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THE ATOMIC AGE

MORE than a year ago, the Atomic Energy Commission of the United Nations gave reasons, which no one attempted to answer, why it could see no hope of further progress towards international agreement, and asked to be relieved of its task. The General Assembly of the United Nations insisted in November that the Commission should try again; but that insistence, perhaps, indicated that the Assembly itself found the situation beyond its powers. Nor have events during the year offered the Commission much guidance as to how to proceed. The majority of the Commission seem to be firmly resolved that a measure of general agreement must come before detailed work can be considered on the allocation of quotas, the stages of procedure for control and the sanctions required with which atomic scientists in the United States are anxious to proceed.

Several books on the general theme, which provide useful material for consideration, have recently appeared. The Halley Stewart Lectures for 1948, which have now been published under the title "The Atomic Age"*, on the whole tend to support this majority view. In the main, these lectures add very little to what was said in the series of talks on atomic energy arranged by the British Broadcasting Corporation in March 1947, or in the discussion by a Chatham House Study Group last year. Prof. P. M. S. Blackett and Prof. M. L. E. Oliphant both took part in the B.B.C. talks, and the latter also participated in the B.B.C. discussion. While the implications for good or ill of atomic energy are stated just as clearly, and there is the same insistence on the need for international co-operation and for a new outlook if man is to enjoy the advantages which may be possible through the application of atomic energy to peaceful purposes, neither they nor any of the other contributors really point the way to a solution of the dilemma that is responsible for the present deadlock.

One of the new contributors, Mr. Lionel Curtis, in a lecture on the political repercussions, argues as fluently and cogently, as in his book, "World Revolution in the Cause of Peace"†, that the only hope lies in the democracies pooling their forces in peace as they pooled them in war. To do this, he urges that they must first create a government to organise and control these forces for the common defence. The whole problem rests on the question of sovereignty ; and to deal with the repercussions of atomic power, we must begin by merging national sovereignties in an international sovereignty. Mr. Curtis's book is of additional value as containing a well-documented account of the various speeches which reflect the trend of public opinion towards Western Union and the Marshall Plan. It includes also a critical review of the evolution of the Federal system in the United States, as well as of The Hague Conference of May 7, 1948, and subsequent steps towards Western Union ; but Mr. Curtis's enthusiasm

* The Atomic Age. By M. L. Oliphant, P. M. S. Blackett, R. F. Harrod, Bertrand Russell, Lionel Curtis and D. W. Brogan. (Sir Halley Stewart Lectures, 1948.) Pp. 149. (London : George Allen and Unwin, Ltd., 1949.) 7*s.* 6*d.* net.

† World Revolution in the Cause of Peace. By Lionel Curtis. Pp xv+167. (Oxford : Basil Blackwell, 1949.) 7*s.* 6*d.* net.

for federation leads him, in stating the theoretical case for federation, to brush aside majestically rather than helpfully the manifold practical obstacles to the process of merging States.

The Halley Stewart Lecture by Lord Russell on values in the atomic age also pleads for a scheme of voluntary federation; but Lord Russell puts all his authority on the formation of a single armed force loyal to one civil authority, which at first must be the government of an alliance in which the United States is paramount. He is as insistent as Mr. Curtis that the dangers of the atomic age require us to modify our adherence to certain of the values upheld by nineteenth-century liberalism, and believes that only by surrendering certain national liberties in this way can we hope to preserve the real freedoms in which creative work and individuality are possible. His lecture is as much an analysis of the idea of national freedom as of the ways of preventing war; but, except in the forthright proposal to accept American leadership, adds very little to what has previously been said.

The really new suggestions in the Sir Halley Stewart Lectures for 1948 are contained in Mr. R. F. Harrod's discussion of the economic consequences of atomic energy. After emphasizing, as becomes an economist, the economic burden involved in defence against atomic attack, particularly the implications of dispersion, he reviews in some detail the credit side; he reaches the broad conclusion that while humanity might gain some advantage in the diversion of nuclear energy into power for economic purposes, it is not at present *a priori* probable that the advantage would be great. Moreover, if the creation of power for economic purposes in the various countries is permitted, its creation for warlike purposes can only be prevented by a very thorough-going and possibly oppressive system of international control. It is clear from the deadlock on the Atomic Energy Commission that international relations are now such that it is unlikely that nations will consent to such a system, and Mr. Harrod accordingly suggests that all nations should agree to forgo the use of nuclear energy for the generation of industrial power for a term of years.

Mr. Harrod's proposition is thus similar to, though not identical with, that advanced two years ago in the United States by Mr. Cuthbert Daniel and Mr. A. M. Squires, who suggested that, for the present, not even the atomic development authority should mine or process fissionable materials or operate reaction piles which would yield significant quantities of nuclear fuel. Mr. Harrod would ask the Atomic Energy Commission to formulate precisely the nature of the inspection that would be needed to secure the enforcement of this agreement, which should not be inconsistent with the retention of piles of moderate size for the provision of materials for research and medical purposes. The far milder form of inspection involved, Mr. Harrod thinks, might well prove acceptable to all the nations.

This view is reasonable, and the suggestion goes some way towards meeting objections on which the U.S.S.R. has based its rejection of the Baruch plan. Nevertheless, it scarcely touches the central difficulty of good faith. Freedom of intercourse and free exchange of information are not only important in themselves, but also are of further value as they contribute to good understanding and to mutual confidence between nations. That question of good faith is as unavoidable in considering postponement of the control of large-scale power production until the world is better prepared for it as in considering the control of atomic energy for purposes of war.

Nevertheless, it is interesting to find that, from outside the purely scientific field, reasoned arguments are being advanced that the world should refrain from exploiting the use of atomic power, except possibly on the relatively small scale required for biological or medical purposes, until mankind is morally and ethically prepared to accept the limitations on national sovereignty which are implicit in the degree of international co-operation essential for effective safeguards against the misuse of nuclear energy. While more specific and limited in form, it reflects the essential idea of the Bishop of Ripon's plea for a moratorium on scientific discovery advanced more than fifteen years ago. Nor is it essentially dissimilar from the arguments advanced from time to time in the scientific world for the planning of science on broad lines so as to secure advance along the whole front by diverting resources from fields which appear to be over-cultivated to those relatively neglected.

Fundamentally, there is inherent in all such proposals a recognition that science is not something apart but an essential element in the life of mankind which needs to be in balance with other elements in human life, and indeed requires for its own well-being that those other aspects should be nourished adequately. The realization of the essential unity of knowledge and of human life has become more widespread in the three years that have passed since a series of broadcast talks on "The Challenge of Our Time" took place, in which scientific men such as J. D. Bernal, M. Polanyi, J. B. S. Haldane and C. H. Waddington participated with historians like E. L. Woodward, philosophers such as A. D. Ritchie and Lord Lindsay, men of letters and others like E. M. Forster, B. Farrington, A. Koestler and V. A. Demant; those talks are now available in book form*. Although Prof. Waddington emphasizes in his essay that there is no real conflict between the humanistic and the scientific approach to the problems of to-day, read consecutively the essays leave the impression of a sharp antagonism between morality and science.

Since the talks were given, it is probably true to say that there has been a much more general recognition of the need for a spiritual basis for world order, and that the problem is much deeper than that of the proper use of science, as Prof. Farrington suggests. Something of this can be seen in the lectures delivered at the opening session in Paris of the United Nations Educational, Scientific and Cultural Organisation in

* The Challenge of Our Time. A Series of Essays by Arthur Koestler, E. L. Woodward, J. D. Bernal, E. M. Forster, Benjamin Farrington, Michael Polanyi, J. B. S. Haldane, V. A. Demant, C. H. Waddington, A. D. Ritchie, Lord Lindsay. Pp. 78. (London: Percival Marshall and Co., Ltd., 1948.) 7s. 6d. net.

November and December 1946, which have also recently been published*. In book form, these addresses show little more unity than the B.B.C. talks referred to above; but they provide the spiritual and philosophical background to that Conference, and that of A. H. Compton and three of those on education are constructive.

Dr. Compton, looking on the advent of atomic energy as a part of social evolution, is not content to stress the increased need for co-operation which comes from such activities; he stresses equally the trend towards more education and the increasing concern with life's objectives. His support of Unesco rests on the ability of that Organisation to further these trends. In his view, the power of nuclear energy to enrich the life of man depends on the peoples of the world learning to work together; they must fit themselves for such co-operation by further education, and must select worthy goals which will harmonize the efforts of all. That conception is implicit in H. E. Wilson's address, "Education at a Crossroads", where the need for social and cultural unity is also stressed, and the need for the specialist to see his work in perspective and in a framework of social relations; and it finds even clearer expression in Prof. C. M. Bowra's address on "International Aspects of Education".

The first duty of education, in Prof. Bowra's view, is the pursuit of truth and the need to teach men and women how to find it. Like Prof. Polanyi, he recalls the old ideal and practice of the travelling scholar, passing easily from one European university to another, and pleads for the restoration of some of those old relations and for giving them a new significance, broader and more humane than before. Beyond this, we should see that each nation makes its special contribution to the common stock, and absorbs much in return without losing its individual characteristics. For this process of unification and synthesis, Prof. Bowra looks to the creation of an international university; such a university might offer a more effective contribution to the unification of science than training men in many fields of science. That there is room for men with training and working sense in many fields of physical and biological science, however, will not be disputed; though whether it is necessary to go so far as is suggested by a group of American scientific workers in a recent issue of *Science* is open to doubt. Elsewhere, Dr. W. Bronk has claimed as a characteristic of American culture the gradual union of the physical and human sciences, and especially of the natural sciences with the social sciences and the humanities. The suggestion certainly seems to indicate a ferment in the American universities comparable with that in Great Britain.

The penetrating lectures on Christianity and history which Prof. H. Butterfield recently broadcast were based on the primacy of the Christian philosophy and also stressed the importance of moral factors in intellectual decisions and mistakes. These lectures, like the writings of such men as N. Berdyaev and R. Niebuhr, Middleton Murry and Lewis Mumford, reveal how a new synthesis of thought is maturing in the minds of great thinkers of our time. The conditions which W. G. Carr defines in the volume of Unesco addresses as necessary for the success of that body are, by and large, those on which the solution of the problem of atomic energy depends. To forgo even for a limited period whatever advantages its development might bring to mankind, even if wise and expedient, is essentially a negative policy; it can only be justified as a temporary expedient if it is accompanied by constructive effort to prepare the world for a positive policy. That point was made most emphatically by Prof. H. C. Urey and Prof. M. von Laue in commenting on proposals by Mr. C. Daniel and Mr. A. M. Squires in a symposium in the *Bulletin of Atomic Scientists* last autumn on the question whether scientific workers should refuse to take part in work for military purposes. They believe that the problem can only be solved by establishing a world government which is strong enough and comprehensive enough to prevent war. This will only come from co-operation and understanding between the nations, which are two of the functions of Unesco. If, as Mr. Carr suggests, Unesco can enlist in its work the help of the outstanding educationists, men of science and other scholars of the world, it may make a really effective contribution to world order, both direct and indirect. But valuable as is every organisation that encourages co-operation and the understanding of all that is involved in such questions as federation and the surrender of sovereignty, the place of creative thinking may be even more important; for from it will emerge the new forms of organisation, and the new means of communicating thought and even information essential to the functioning of a real world community. The synthesis of thought of which there are now such welcome signs can be the source of the vision and the spiritual power required to revitalize our civilization and build a new order in which the noblest elements of man's rich cultural and spiritual heritage find their place side by side with the wider and more potent powers which the new knowledge has placed at his disposal.

* Reflections on Our Age: Lectures delivered at the Opening Session of Unesco at the Sorbonne University, Paris. Pp. 347. (London: Allen Wingate (Publishers), Ltd., 1948.) 18*s*. net.

UNIVERSAL PRINCIPLES

The Unitary Principle in Physics and Biology

By Lancelot Law Whyte. Pp. x+182. (London: Cresset Press, 1949.) 12*s*. 6*d*. net.

THIS book demands serious attention for more than one reason. It represents a significant stage in the course of a line of thought which has been followed for many years and of which the earlier stages have already been described in a succession of writings. The author is, moreover, not—as often in such undertakings—blinded to weaknesses in his arguments by ignorance of essential facts; Mr. L. L. Whyte has a wide knowledge of modern science and the ability to understand its purport. Finally, the problem with which he deals is so fundamental that, if his work is sound, it cannot fail to be of great importance.

Mr. Whyte's aim is to discover a principle underlying all science—physical, biological and psycho-

logical—and providing an adequate foundation for it. Up to now the deepest and most general concepts of science have been Newtonian quantitative concepts, and these, though adequate in the past, are now unable to support even physics itself. A more profound basis can be discerned in mathematical logic, which is more general than mathematics itself, and here it is the logical theory of relations that meets our need. Relations are of two kinds—symmetrical and asymmetrical—and of these the latter are the more general since they include the former as a limiting case. Applying this idea to the special circumstances of scientific study we arrive at the "Unitary Principle", which Mr. Whyte advances as "the axiom of a potentially universal science"; it is stated as follows: "*Asymmetry tends to disappear, and this tendency is realised in isolable processes*". Asymmetry here means "an observable deviation from some type of three-dimensional spatial symmetry latent in a system, or in a finite part of a system". "Unitary theory" is concerned with this tendency towards symmetry in all fields, though the principle applies "only directly to ultimate structure". Asymmetry is the cause of change, and symmetry the basis of stability. "The task of unitary theory is to display the unitary process everywhere. To recognise the causal development of any system it is necessary to identify the particular type of decreasing asymmetry which characterises it." Mr. Whyte proceeds to apply the principle to certain fields of science, mainly biochemical; but he makes no claim that he has yet established the universal validity that he believes it to possess. His book is "a draft formulation" submitted to the reader for his criticism and co-operation.

I accept the first part of this invitation with reluctance, for I would have preferred to write of such a labour of love with more approval than I can. In the first place, there are difficulties connected with the idea of 'asymmetry' that I have not been able to surmount. We are clearly told, in the statement of the unitary principle, that it means three-dimensional spatial asymmetry; but, if that is so, how can the principle provide a basis for psychology, of which the fundamental concepts are non-spatial? The reply may be that in the most general form of the principle the asymmetry must be logical and that spatial asymmetry is only the special form it takes when applied to material structures; but then one meets the difficulty that spatial asymmetry is not a special form of logical asymmetry, for it is logically symmetrical. If A is asymmetrical with B, then B is asymmetrical with A; and, in fact, all non-quantitative words like 'unequal', 'different in form', 'dissimilar'—no matter how strong the contrast they denote—pertain to logically symmetrical relations. The precise meaning of the unitary principle thus remains obscure.

There is a similar difficulty with the word 'isolable'. If the tendency towards symmetry is actually realized in a process, it would seem that that process must be isolated and not merely isolable, for one can always reverse the tendency by controlled interference without making the process unisolable. But when we consider the most isolated process we know—a rotating mass of gas in interstellar space—we find that, whether it becomes a double star or a solar system or a spiral nebula or any other plausible configuration, its asymmetry increases; we can scarcely admit that it will develop from a slightly oblate spheroid towards a perfect sphere. Mr. Whyte's discussion of the principle suggests that he would reply that if, in fact, the asymmetry increased, that would be an indication that the system was not isolated and that one must therefore look to the rest of the universe to account for what had happened. The principle would thus become a mere definition like Newton's first law of motion; tendency towards symmetry would be the only possible criterion of isolation, just as uniform motion is the only possible criterion of absence of force. But the whole significance of Newton's laws lies in the fact that the first is supplemented by the others and by the law of gravitation, so that when non-uniform motion is observed, we can not only deduce a force, but also determine its magnitude and character in terms of the observable surroundings. Without that supplement, one might, with equal validity and equal futility, say that a free body would move in a spiral—as, in fact, Swedenborg did. It is not clear that Mr. Whyte has found the corresponding supplement to his principle, and without this the principle does not take one very far.

These seem to me to be serious difficulties; but the fundamental objection which I feel to the whole scheme is that it is one more example of the tendency, so dangerously manifested in these days, to return to the method of philosophizing which the science of Galileo and Newton was created to destroy. There is a family likeness between the unitary principle and the principles that Nature abhors a vacuum and that everything seeks its own place. True, there are 'principles' in science; but they are arrived at as the culmination of an unprejudiced examination of phenomena and not taken as initial axioms to which phenomena are expected to conform. The laws of thermodynamics, for example, were conclusions from studies of mechanical and thermal phenomena which originally were conducted quite independently of one another—one with the simplest motions of falling bodies and the other with imperfect thermometer readings. Their union came when, by the free development of each, they naturally grew into one another. The same thing is true of the laws of electro-magnetism, of general relativity, and so on. They are not necessarily, or even probably, final; a relativistic thermodynamics, for example, must certainly be different from the thermodynamics of Clausius and Kelvin. It is an essential characteristic of science that it approaches the general through the particular and refrains from distorting its apprehension of the particular by premature generalization. The unity of science is an end to be attained, not a dogma from which to start.

That Mr. Whyte's generalization is premature is only too evident. To find a principle common to a science of physics which, according to some thinkers, is nearing completion, and a science of psychology which, according to all, has scarcely begun, is inevitably to put oneself in the company of the dialectical materialists, the kinematical relativists and others, whose universal, fundamental principles of Nature are alike seductive and baseless and are further alike in being all incompatible with one another. If one likes that kind of thing, one can take a choice between the principle that all things generate their contraries with which they then identify themselves, the principle that all experience must be expressible in terms of the intuitive apprehension of the passage of time, the principle that in all isolable processes the tendency to disappearance of asymmetry is realized, and any other principle that one

can think of. I know of no way of choosing between them; it seems to depend on which siren's voice sounds the sweetest. I can only recommend, in the strongest possible terms, a liberal use of wax and straps.

All this, of course, does not mean that Mr. Whyte's book may not be of very great importance, for while the unitary principle may be a tyrant as a universal dictator, it is possible that it can be made a most effective slave. A universal principle that nothing can be created or destroyed would have been disastrous to science, for it would have prohibited the conception of entropy, yet conservation laws are of the greatest value in restricted fields. The greater part of Mr. Whyte's discussion is concerned with the application of his principle to biochemical problems, on which I am not competent to speak. It would be very regrettable if the general inadmissibility of the unitary principle were to lead to the ignoring of its possible usefulness in particular departments of study.

HERBERT DINGLE

TWO TOPICS IN THEORETICAL PHYSICS

Two Lectures

1. The Present Situation in the Theory of Elementary Particles; 2. Electron Theory of Superconductivity. By W. Heisenberg. Pp. 52. (Cambridge: At the University Press, 1949.) 3*s*. 6*d*. net.

THESE lectures, delivered in December 1947 at the Cavendish Laboratory, Cambridge, deal with two unconnected topics of theoretical physics.

The attitude of the author to the theory of elementary particles differs rather from that of the majority of theoretical physicists, who have spent a great amount of ingenuity and mathematical skill in an endeavour not to solve, but to eliminate, the difficulties of atomic theory arising from the appearance of infinite terms. In opposition to this 'subtraction physics', Prof. W. Heisenberg regards the divergences as a natural, and therefore satisfactory, feature of the present theory which cannot claim to be more than an application of the correspondence principle to a yet unknown field. Heisenberg outlines the general properties of this physics of the future in which all kinds of particles will be treated by one and the same formalism, the main parameter being the rest-mass. He sketches a diagram of the spectrum of rest-masses, representing the lowest states of the super-Hamiltonian to be discovered, and he thinks that it reveals already "a great deal" about the future theory, the most startling fact being the extreme stability of states that lie as high as the proton mass.

Yet he expresses doubts whether the Hamiltonian formalism is at all suited for this very general problem and indicates as an alternative his S-matrix method, which describes primarily the scattering of particles, but allows also the determination of stationary states of compound systems. Heisenberg points out that the S-matrix has a closer relation to immediate results of observation, thus using a philosophical argument which once led him to his greatest success, the discovery of quantum mechanics.

The theory of superconductivity is a problem of a very different type; here the fundamental laws are well known; but the phenomenon is of such a complicated nature that no consistent picture has so far been developed. Heisenberg moderately claims no more than a unification of previous disconnected, and sometimes discordant, theories of different aspects of the phenomenon. In fact, he offers a well-balanced, systematic, though somewhat sketchy, presentation, based on the following assumptions. Perfect conductivity, not diamagnetism, is the primary feature, and it is produced by electric (Coulomb) interactions of the electrons, not by magnetic forces (as other authors have assumed). These interactions lead to a kind of condensation of the electrons which form an ordered system, an electronic lattice, corresponding in the momentum space to an asymmetric deformation of the Fermi sphere. The destruction of superconductivity by a magnetic field is attributed not to a direct action of the field but to the production of stresses in the electronic structure (London stresses), which increase the free energy beyond the point where the superconducting state is stable. The Meissner effect is interpreted along the lines previously suggested by London.

Some of these assumptions seem to be open to criticism, and some important aspects are not discussed (such as the correlation of superconductivity to the lattice structure, discovered by Cheng). Yet the study of this fascinating lecture can be recommended to all interested in the subject.

M. BORN

NATURE'S CONTINUOUS CHANGE

The Floral Year

By L. J. F. Brimble. Pp. xiv+622+25 plates. (London: Macmillan and Co., Ltd., 1949.) 30*s*. net.

"THE FLORAL YEAR" has been written by a botanist who, for some years, has been preparing works on natural history which, while losing nothing in objectivity, were deliberately aimed to win the interest of the inquiring layman by appealing to his love of the æsthetic. In 1944 he published a book called "Flowers in Britain" which so skilfully combined the scientific and artistic approaches that it became a best-seller. Its success was soon paralleled by a companion volume, "Trees in Britain", which, the evidence shows, has considerably added to the number of tree-lovers in Britain. Two other works of this type dealing with birds and dogs have since appeared under the editorship of L. J. F. Brimble, and their public reception has been worthy of Brimble's own works.

The considerable appeal of these four books has led Brimble to attempt what must surely be the most ambitious venture of its kind to date. While "The Floral Year" will be warmly welcomed by botanical scholars, the author has designed it primarily for the general reader who is interested in field natural history. That the book would be well received by such readers is borne out by the publisher's confidence in the author in producing the book on such a lavish scale and, inevitably, at such a price. Their confidence has been well placed. Already the book has been greeted in rapturous terms in some of the more literary journals and has been selected by the Book Society (which has a strong selection committee of literary authorities) as one of its recommended books for June.

The general pattern of the book may be seen from the sectional headings into which it is divided. To help the beginner there is an introductory section containing a short review of the plant kingdom together with chapters describing the morphology, physiology, ecology and systematic classification of plants. Brimble then begins his pageant of Nature, with the calendar as guide, by considering deciduous trees in winter. In February, he examines the stirrings in woods and copses, hedges and banks and open spaces, and, in March, adds to his studies an investigation into the plant life of marshes and river banks. So his panorama unfolds. In April, he examines trees and shrubs, woods and hedgerows, fields, waste places and heaths, weeds, old walls, marshes, river banks and coastal areas. All these are re-examined in May, while the author also looks at thickets, meadows, cultivated land, mountains and moorlands, damp meadows, ditches and streams.

The profusion of June is described under the chapter-headings of trees, woods and thickets, the canopy of hedges, undergrowth of hedges, field and meadow grasses, fields, meadows and pastures, waysides and waste places, more weeds, mountains, moorland and heath, walls, moisture-loving plants, semi-aquatics and aquatics and coastal areas. July is similarly considered; but, while in August opportunities for study grow less, there are still woods, fields and meadows, more weeds, waste places, heaths, wet places and coastal areas to be investigated. The remaining months of the year are grouped together and considered under the headings of autumn flowers, seed-time and harvest, autumn tints and leaf-fall, and evergreens, the drama concluding appropriately with the enchanting story of Christmas customs and festivals from the botanist's point of view. It is a tribute to the way in which this book has been arranged that, despite the straightforward calendar arrangement, the reader may begin to read at the current season of the year and at once take up the theme. Here the author has given considerable help by providing an adequate series of cross-references both as part of the text and at the end of each chapter.

Besides its arrangement the manner in which the text has been written itself adds enchantment to the book. Descriptions of plants are given in precise, short-syllabled words to which no botanist would take exception. The force of these descriptions is strengthened by the generous use of quotations in prose and poetry from literature and folk-lore which themselves add to the charm of the book. Nor does the author fail to make use of the economic significance of plants to enliven his text, while the introduction of relevant anecdotal passages not only increases the human interest of the book but also shows that its contents have been lived as well as learned.

The other outstanding feature of this remarkable book is the range of illustrations. These are prodigal in number, rich in quality and dominated by twenty-five specially commissioned colour-plates the originals of which were executed in tempera by Mr. W. Reeves. Harmonizing with these are many characteristic line-drawings prepared by the author himself, while there are also several hundred photographs which have been taken by specialist photographers who are themselves well known as naturalists. Unfortunately, some of these have not reproduced well and form, perhaps, the only blemish in this book.

That the book should have the maximum utility is shown by the inclusion of two indexes, one concerned only with botanical names and one with topics of general and particular interest. The whole book is, indeed, a tribute to the perspicacity, acumen and industry of the author, and no doubt will grace our shelves for many years. Brimble's reward will be the reader's gratitude for this classic work.

T. H. HAWKINS

RURAL LIFE AND WORK

Family Farm Policy

Proceedings of a Conference on Family Farm Policy, attended by participants from the British Commonwealth, Northern Europe, Central Europe, Latin America, and the United States, held at the University of Chicago, February 15–20, 1946. Edited by Joseph Ackerman and Marshall Harris. Pp. xxii+518. (Chicago: University of Chicago Press; London: Cambridge University Press, 1948.) 22*s.* 6*d.* net.

THERE assembled in 1946 at the University of Chicago, by invitation of the Farm Foundation, a gathering of seventy-six persons of diverse interests connected with the land to discuss problems of tenure, especially in their relation to the family farm. This volume is the report of that conference. It has an international flavour, some three-fifths of it consisting of authoritative papers on the land tenure systems of a dozen different countries; but it is on the United States that attention is focused, not surprisingly, seeing that ninety per cent of those present were from that country.

They accepted, a little too readily perhaps, the popular view that the family farm is the best form of agricultural organisation for providing the farmer with a satisfying life—whether it is the best also for feeding the world did not appear—and this conclusion was reached in spite of the serious disadvantages under which many family farms were seen to labour and with little or no examination of other important types of farm. The usual preference in the United States for ownership as against tenancy was re-affirmed; but the drawbacks of tenancy in that country were admitted to be due, at least in part, to a lack of statutory provisions such as exist in some other countries for safeguarding the relative positions of landlord and tenant. There is no simple answer to the old question whether the proud owner of a heavily mortgaged holding is really better off than a tenant free of debt, though the question never seems so insistent after a few years of high prices and reduced indebtedness.

Other problems which received attention were: land settlement, which tends to become prominent after a war, taxation, excessive subdivision of small properties on one hand and limitations on the size of large holdings on the other; and the needs of the landless worker who, in the United States, seems to enjoy no legal standards for his wages, hours of work, compensation for injury, or social security.

The value of this report—and it is considerable—lies in its bringing many complex problems into view, rather than in attempting to solve them. It takes its place as a significant contribution to questions of land tenure which vex much of the world to-day, and which, unfortunately, respond less to scientific and economic reasoning than to political prejudice.

R. N. DIXEY

PHYLLOTAXIS AND ORGANOGENESIS IN FERNS

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FROM experimental studies of phyllotaxis in flowering plants, M. and R. Snow[1] concluded that the next leaf primordium to be formed will arise in the "next available space" on the apical meristem, that is, the first space or gap between existing primordia that attains a certain minimum width and which is situated a certain distance below the extreme tip of the shoot. They showed that the position of the new primordium within a gap can be modified by experimental treatment and that it is determined by those primordia which abut on the gap and not by *all* the primordia of the top cycle. In comparable experiments with *Dryopteris aristata* Druce, I obtained evidence which substantially supports these findings[2]. In ferns, an evident feature is that the newly formed primordium occupies only a small part of the interfoliar meristematic area. There is evidence that tensile stresses are induced in the fern apical meristem by the existing leaf primordia, new primordia typically arising in regions of minimal stress. Accordingly, it has been suggested that these stresses may determine, or define, the space in which the next primordium can be formed; but that other factors are probably responsible for leaf formation[3].

In studying organ formation at the fern apex we have to account for the very curious fact that whereas leaf primordia are formed, shoot buds are not, although the rudiments of both lateral organs are histologically identical[3]. Now why should one group of cells of the apical meristem, those in a presumptive leaf position, be able to grow out and form a primordium—a leaf primordium—whereas an adjacent but closely comparable group, those in a presumptive bud position, remain inhibited in respect of organ formation? It seems clear that any adequate account of organogenesis at the fern apex must not only include leaf formation but must also include the phenomenon of bud inhibition.

A unifying conception of morphogenetic processes that is emerging from contemporary biological investigations involves a recognition of the existence of *growth-centres*. It is held that each growth-centre, by its metabolism, gives rise to a physiological field within which a new growth-centre cannot originate; but a new centre may arise in meristematic cells outside the field. In 1913, Schoute[4] put forward the view that in the process of leaf formation the leaf-centre is determined first, the primordium being organised around this centre. He also held that a specific substance is produced by leaf growth-centres which inhibits the inception of others in the immediate vicinity. Hence new primordia only arise between older ones when the space on the meristem has become sufficiently large. The new centre is typically situated at the point of intersection of equal circles drawn around the two adjacent primordia. In Schoute's hypothesis the inhibition of new growth-centres by the shoot apex was also postulated: hence the position of a new primordium well down the side of the apical cone. The substance proceeding from the apical cell was considered to be somewhat different from that produced by the leaf-centres. The conception of growth-centres and their relation to organogenesis have recently been given support by Richards[5], and Bünning[6]. In the course of studies in which the apical meristem of *Dryopteris aristata* was incised in various ways, certain developments gave a strong indication that Schoute's ideas, suitably modified, might provide the basis for a comprehensive conception of morphogenesis and the regulated development to be seen at the shoot apex in ferns.

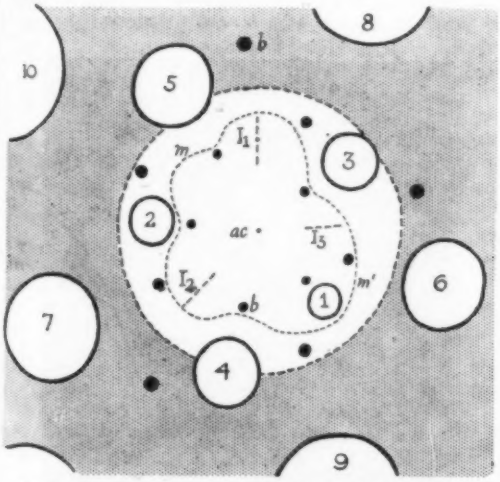

Fig. 1. Diagrammatic representation of the apex of *D. aristata* as seen from above. 1, 2, 3, etc., leaf primordia in order of increasing age; I_1, I_2, etc., the next primordia to be formed, in the order of their appearance; *ac*, apical cell; *m*–*m'*, indication of apical meristem; the circular broken line indicates approximately the base of the conical apical region; *b*, approximate bud positions

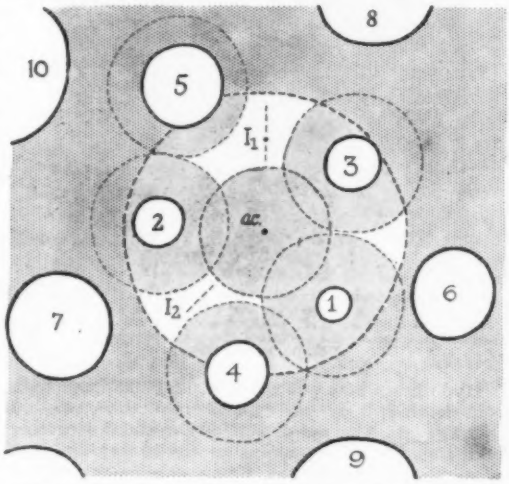

Fig. 2. Diagram as in Fig. 1, the shoot apex and each leaf primordium of the top cycle being regarded as a growth-centre, with a surrounding physiological field in which new growth-centres cannot arise. I_1 is the first space on the apical meristem which is free from this inhibition and therefore becomes the site of a leaf primordium

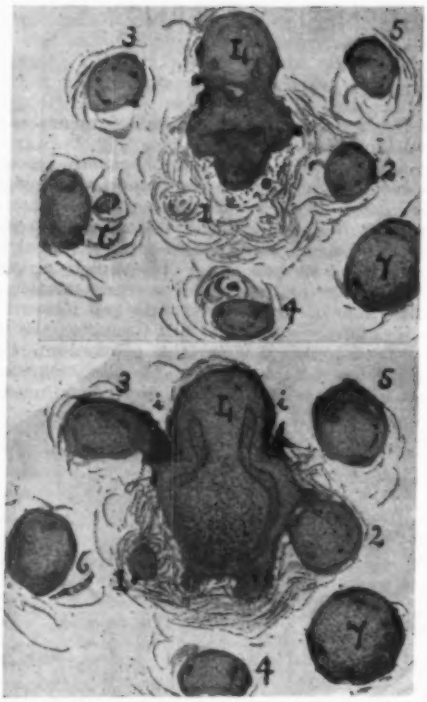

Fig. 3. Two sections of an apex in which the position I_1 was isolated by radial incisions (*i*) from P_2 and P_3. The new primordium which has appeared at I_1 has grown rapidly and has become considerably larger than some of the older primordia. (× 9.) (Photo: Ernest Ashby)

Hypotheses now put forward, and sustained by a considerable body of experimental data, are as follows: (1) The apical cell of the shoot (together with its adjacent segments), as also each young leaf primordium, constitutes a growth-centre with a surrounding physiological field; new growth-centres can only originate in regions of the apical meristem which lie outside the existing physiological fields. (2) No fundamental metabolic differences exist between shoot and leaf apices; but there may be differences in the extent (or intensity) of their fields. (3) The physiological field round a growth-centre is established at an early stage; that is, a field develops round a leaf primordium contemporaneously with or very soon after its inception.

The application of these ideas to the fern apex is illustrated in Figs. 1 and 2. The positions of the existing leaf primordia (*P*) (1, 2, 3, etc., in order of increasing age) and of primordia yet to be formed (I_1, I_2, I_3, in the order of their appearance) are shown. Approximate bud positions (*b*) are indicated in Fig. 1. These are situated some distance above the axils of the leaf primordia; they may also be described as occupying lateral or *interfoliar* positions. It will be seen that in respect of their distance from the apical cell, some bud positions are closely comparable with those of the more recently formed leaf primordia. Nevertheless, bud rudiments remain inhibited whereas leaf primordia are formed. Fig. 2 illustrates the growth-centre hypothesis as it may apply to the fern apex, physiological fields being shown in relation to the apical cell and the adjacent leaf primordia (P_1–P_5). Needless to say, this rendering is simplified and arbitrary: it will at once be evident that many different representations are possible. But, as investigations progress, it may be possible to indicate with some degree of precision the shapes, sizes and physiological properties of the several fields. For the time being, the assumptions are made that each leaf primordium develops its effective field at an early stage and that the field of the apical cell extends well down the flanks of the cone. As shown in the diagram, the next area of the apical meristem—the "first available space" of M. and R. Snow—which is free from the inhibitory effects of adjacent growth-centres and in which a primordium could develop, is the position normally occupied by I_1; the next space to become available after that is that normally occupied by I_2; and so on. Bud positions, on this hypothesis, are subject to inhibition by the young leaf primordia, that is, the inhibition of buds *at the apex* is not solely due to the shoot apex.

The hypotheses indicated above can be subjected to experimental tests: it should be possible, by the partial isolation of particular regions, to observe whether or not inhibitional effects are, in fact, associated with the inception and growth of primordia. Some typical experiments and the inferences drawn from them are briefly indicated below.

When the apices of the leaf primordia of the top cycle (P_1–P_5) were punctured or incised, the new primordia (I_1–I_4) were formed in their normal positions. From this it is inferred that fields are established contemporaneously with, or soon after, the inception of primordia.

When the position of the next primordium to be formed, that is, I_1 (situated between P_2 and P_3), is isolated by two radial incisions, the primordium formed at I_1 soon becomes larger than the older primordia, P_1, P_2 and P_3 (Fig. 3). It is inferred that the inhibitive or regulative effects of P_2 and P_3, the adjacent primordia, have been precluded by the incisions. Comparable results were obtained when P_1, P_2 or P_3 were similarly isolated (Fig. 4). (In these and related experiments the effect of wound hormones has still to be evaluated; the evidence suggests that such effects are localized near the wounds.)

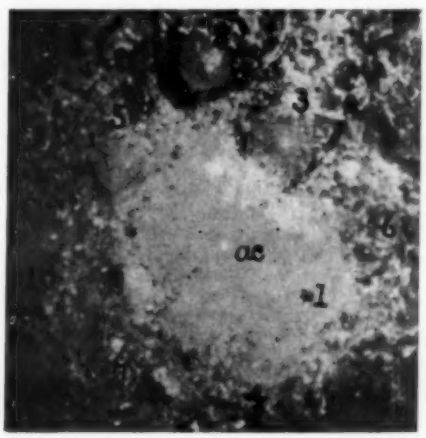

Fig. 4. An apex, seen from above, in which P_3 was isolated by two radial incisions. This primordium has become considerably larger than P_4 or P_5, both older primordia. (× 25.) (Photo: Ernest Ashby)

When radial incisions are made through the positions I_1 and I_2, the next primordium to be formed, I_3, arose in its normal position; but I_4 was displaced towards the I_1 incision, and I_5 towards the I_2 incision. Moreover, I_4 was soon larger than I_3, and I_5 as large as I_3. These displacements of I_4 and I_5 and their large relative size are considered to result from the absence of physiological fields at I_1 and I_2.

In the normal development, leaf primordia are formed on the sides of flanks of the apical cone. As the growth-rate is considerably greater on the abaxial than the adaxial side and as the latter may also be subject to inhibitive effects proceeding from the shoot apex, the dorsiventral symmetry of foliar members seems a natural consequence. Buds, on the other hand, typically arise in interfoliar positions in the sub-apical or adult regions of the shoot. When the position I_1 was isolated from the apical meristem by a tangential incision, or by a tangential and two radial incisions, a large solenostelic *bud* developed in a majority of the experimental materials; that is, a bud was induced in a presumptive leaf position, Fig. 5. In such experiments inhibitive effects from the shoot apex on I_1 will have been precluded; there also appears to be a levelling up of the growth-rates on the abaxial and adaxial sides. (Very occasionally, a leaf primordium was formed at I_1; in some instances a leaf and a bud appeared to have been formed contemporaneously.)

Perhaps the most interesting experiments were those based on the following considerations. In ferns, buds, which may be described as axillary, are actually situated on the shoot a little above the leaf axil. They are more aptly described as being interfoliar. Bud positions occur on the meristem at about the same level as the top cycle of leaf primordia (Fig. 1). Bud formation in these positions is, however, inhibited in the normal development. (These inhibited bud rudiments, that is, groups of meristematic cells, become distributed in characteristic positions along the shoot during growth. They have been described as detached meristems[7] and will give rise to shoot buds when the apex of the shoot is destroyed or inactivated.) On the hypotheses under consideration, the inhibition of buds at the apical meristem is attributed partly to the shoot apex and partly to the adjacent

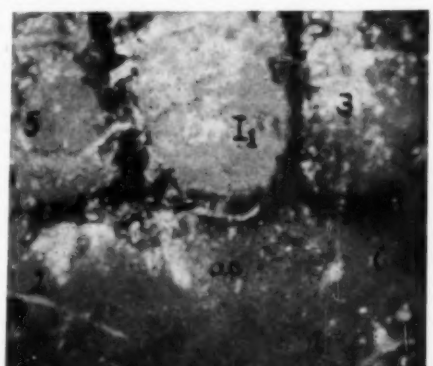

Fig. 5. An apex in which the I_1 position was isolated from the shoot apex by a tangential incision, and from P_2 and P_1 by radial incisions. A *large solenostelic bud* has been formed in the presumptive leaf position. (× 40.) (Photo: Ernest Ashby)

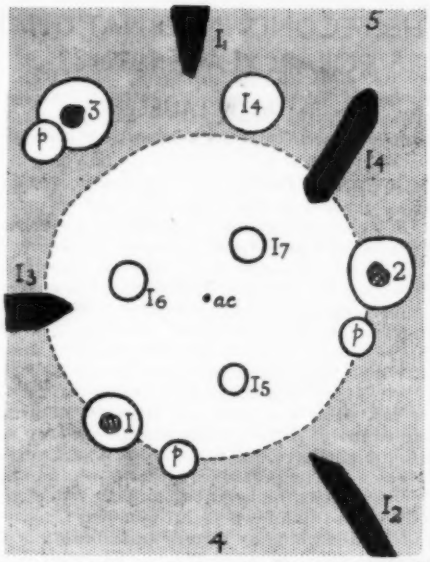

Fig. 6. Downward view of an apex, after further growth, in which the apices of P_1–P_5 had been punctured and positions I_1–I_4 incised. New leaf primordia (p) have been induced in interfoliar positions, that is, *in what are normally bud positions*. New primordia have also been formed on the apical meristem

leaf primordia. It was, therefore, argued that if (a) the apices of P_1–P_5 were punctured, and (b) positions I_1–I_4 were punctured or incised so that the development of their physiological fields would be precluded, conditions would have been established which would admit of the formation of lateral organs in the normal bud positions at the apex. In a considerable series of experiments along these lines, *leaf primordia* have been induced in positions between the existing leaf primordia, that is, in what are normally bud positions. These *experimentally induced leaf primordia* were typically basal or lateral to P_1–P_5 and axillary to the older primordia P_6–P_{10} (Fig. 6). The leaf primordia which were formed on the further growth of the apex were in approximately normal phyllotactic sequence with the induced primordia.

It is concluded that these experimental data are compatible with the following views: (1) the positions in which lateral members arise on the apical meristem, and the regulated development of the leafy shoot, can be referred to growth-centres and their physiological fields; (2) the apical meristem is totipotent, the essential differences in the morphology of leaves and buds being due to the positions in which they are formed; that is, leaves and lateral shoots, viewed as distinctive organs, are not specifically pre-determined either by the hereditary constitution of the organism or by the pre-existence in the race of organs of different fundamental categories; (3) with certain qualifications, the shoot apex is a self-determining region. A fuller account of these investigations will be given elsewhere.

[1] Snow, M., and Snow, R., *Phil. Trans. Roy. Soc.*, B, **221**, 1 (1931); **222**, 353 (1933); **225**, 63 (1935); *New Phyt.*, **46**, 15 (1947).
[2] Wardlaw, *Ann. Bot.*, N.S., **11**, 97 (1948); **13**, 163 (1949).
[3] Wardlaw, *Phil. Trans. Roy. Soc.*, B, **233**, 415 (1949).
[4] Schoute, *Réc. Trav. Bot. Néerl.*, **10**, 153 (1913).
[5] Richards, Symposium on Growth, S.E.B., No. 2 (Camb. Univ. Press, 1948).
[6] Bünning, "Entwicklungs- und Bewegungs-Physiologie der Pflanze" (Springer, Berlin, 1948).
[7] Wardlaw, *Ann. Bot.*, N.S., **7**, 171 (1943).

THE SECOND INTERNATIONAL POLAR YEAR, 1932–33

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THE plan for the First International Polar Year was devised in the year 1875, and its purpose was to establish a number of outlying observation stations in the arctic and antarctic regions and to enable these stations to undertake geophysical observations for one year according to a prescribed common programme. The reasons underlying the plan were not only the great scientific interest of geophysical conditions in the polar regions and the close interrelation which was known to exist between these conditions and the corresponding conditions in lower latitudes, but also the practical importance which a more thorough knowledge of this interrelation might have, for example, within the field of meteorology. The procedure hitherto used in exploring polar regions, namely, the sending out of single expeditions to unknown or little-known places, was of but limited value as regards the solution of such world-wide geophysical problems. The plan for the Polar Year, of course, also embraced investigations of such special phenomena as, for example, auroras, the occurrence of which is mainly limited to polar regions, and on the extent and physical nature of which simultaneous systematic observations from a large number of stations must be expected to yield valuable information.

The First Polar Year was implemented in the period August 1882–August 1883, and was a decided success. The total human effort made was immense, and the scientific results attained meant an enormous increase of the knowledge at that time available on meteorology, terrestrial magnetism, aurora and other geophysical phenomena. It was an acknowledgment of the great practical and scientific results of the First Polar Year that the proposal for a Second International Polar Year in 1932–33, fifty years after the First Polar Year, was greeted with enthusiasm from all quarters.

At the International Meteorological Conference in Copenhagen in 1929, where the plan was thoroughly discussed and endorsed, the practical accomplishment of the large-scale enterprise was placed in the hands of a special international commission, the Commission of the Polar Year 1932–33. The Commission was composed of prominent and influential men interested in the branches of science covered by the programme of the Polar Year, and included especially representatives of the countries with large possessions in the Arctic. Dr. D. la Cour, director of the Danish Meteorological Institute, was elected president of the Commission, and all who in one way or another were engaged in the implementation of the Second Polar Year will recognize the immense importance for its successful accomplishment of Dr. la Cour's never-failing energy and indefatigable work.

The universal enthusiasm met with in all scientific circles had to face the world-wide economic depression of the early thirties, so that even in the midst of preparations voices were demanding that the entire plan be deferred. However, optimism carried the day, and in spite of all economic difficulties the Polar Year was carried through during August 1, 1932–August 31, 1933, and provided a noteworthy example of international collaboration within the field of science.

Notwithstanding the fact that the plan was implemented under the designation "The International Polar Year 1932–33", much weight was attached in the course of the planning to the world-wide character of the investigation. Thus an attempt was made to establish observation stations not only in the polar regions but everywhere on the earth where such stations were found to be lacking, or where they were found to be too widely scattered to give the desired complete picture of the geophysical conditions investigated. Consideration was also given to the intensification of observations taken at existing stations, in order that they might be fitted into the world-wide observational programme drawn up by the Polar Year Commission.

When on August 1, 1932, the Polar Year was initiated, not less than forty-four countries had undertaken to participate in one way or another within the framework of the programme established. Twenty-two countries out of these forty-four sent out special expeditions, several of them for the purpose of establishing new stations outside the borders of their respective countries.

It should be stated at once that the immense work which had been expended on the part of the Polar Year Commission on the planning of the observations, and the economic sacrifices made by the participating countries in order to implement the programme, were amply rewarded through the exceedingly abundant and valuable material collected during the year by the observers at the individual stations, often under very difficult conditions and at considerable personal expense. The material available from the Polar Year has exerted, and will exert, a decisive bearing on development within the respective branches of geophysics.

It must be admitted that the rapid development of recent years regarding the extent of the network of stations, as well as a highly improved technique in the taking of observations, have in certain respects provided far more ample material than that yielded by the Polar Year. This is especially true in connexion with the exploration of the upper air, which, due to the development of the *radio sonde* technique, has made enormous progress, especially during and after the Second World War. But, on the whole, the observations from the Polar Year must be characterized as the most extensive and the most homogeneous material ever placed at the disposal of geophysicists.

On the basis of the synoptic meteorological observations from a network of stations unprecedented in extent, meteorologists were thus able to form a true picture of weather conditions over practically all parts of the earth at a given time, and to follow the development of these conditions in a far more exhaustive way than ever before possible. In this connexion reference should be made to the collection of synoptic weather maps for the northern hemisphere, one map for each day of the Polar Year, published by the International Meteorological Organisation with the support of the Meteorological Association through the International Geodetic and Geophysic Union and of the Rockefeller Foundation.

The magnetic stations have provided primarily a unique number of recordings which permit the variations of the geomagnetic field to be followed minute by minute through the entire Polar Year in so many places on the surface of the earth that

neither before nor since has the magnetic field of the earth been subjected to a corresponding control. Hence practically all the more recent theoretical investigations in this field have been based wholly or partly on the recordings of the Polar Year. In the Polar Year observations the application of a supplementary recording device with manifold paper-speed made it possible to study even the most rapid variations of the magnetic field, while at the same time the exact timing made it possible to draw more accurate conclusions as to the degree of simultaneousness with which world-wide magnetic disturbances occur at different points on the surface of the earth. The extensive use of this new type of instrument was made possible through the most generous support by the Rockefeller Foundation.

At the same time as the variations of the geomagnetic field were thus being observed on an unprecedented scale, detailed observations of auroras were undertaken at all stations in higher latitudes, thus providing extensive material for the elucidation of the interrelation between these two phenomena.

The propagation of radio waves over various parts of the earth and the variation of propagation with geomagnetic or other disturbances were also studied in detail through specially arranged international radio broadcasts, which at specified hours were received by a large number of stations all over the world.

Many other investigations, for example, investigations in atmospheric electricity, earth currents and cosmic radiation, formed to a greater or smaller extent part of the observational programmes of the individual stations. Such investigations, which, of course, in themselves are of scientific value, gain increased importance during the Polar Year, since they were undertaken concurrently with investigations of other phenomena from adjacent geophysical regions, so that it becomes possible to trace any interrelation with these phenomena; further, since the investigations were undertaken simultaneously over large areas of the earth, it is possible to decide whether a phenomenon is of a purely local or perhaps of a world-wide character.

It is in full harmony with the international character of the Polar Year that, in planning the work to be undertaken, exceedingly great weight was attached to the fact that the observations were to be made available for all men of science interested, and during the years following the Polar Year a very large number of valuable publications has been issued. The first to be published were expedition reports and reports from institutions all over the world which had taken part in some way or other in the work and which now made their observations available for scientific research. There followed in rapid succession papers and treatises based on the observations published, showing that the expectations with which the results of the Polar Year had been awaited had not been exaggerated.

No doubt it will be possible to build for a long time to come on the observations of the Polar Year, as well as on the analyses of this material already available. This will, however, require that the scientific workers who are to-day working on geophysical subjects—and who already belong partly to a generation younger than the one which planned and carried through the Polar Year—should be able to obtain a comprehensive view of the existing material of analysed and unanalysed observations, as well as of the number of scientific treatises on them already published. The International Commission of the Polar Year was formally dissolved when the International Meteorological Organisation met for the first time after the War (London, 1946); but at the following meeting of the International Meteorological Committee (Paris, 1946) a Temporary Commission was set up, charged with the task of completing and rounding off the work of the Commission of the Polar Year. This Temporary Commission has been charged, *inter alia*, with the preparation of a bibliography of all publications relating to the Polar Year. Dr. J. A. Fleming, Carnegie Institution, Washington, is president of the Commission, and a special Central Bureau has been established at the Danish Meteorological Institute, where Dr. la Cour had already before the War collected very extensive records on the Polar Year. The Rockefeller Foundation has renewed an appropriation which had been granted earlier in support of the continued work of the Commission of the Polar Year, but which on account of the War it had not been possible to utilize. The greater part of these funds will be used for the preparation and printing of the bibliography mentioned above. Institutions and scientific workers, who in any way have contributed towards the accomplishment of the programme of the Polar Year or have benefited from the results of the Polar Year, are asked to assist the Central Bureau in its efforts to make the bibliography as complete as possible.

The work of the Temporary Commission is to be completed by the end of 1950, and it is to be hoped that the results of its work may prove beneficial to the men of science who may be expected for many years to come to resort to the almost inexhaustible fund of observations from the Polar Year in such cases where the solution of a geophysical problem requires a uniform, simultaneous material of observations from the entire surface of the earth.

MODERN METHODS OF MINERAL EXPLORATION

AT the Fourth Empire Mining and Metallurgical Congress held in London and Oxford during July 12–15, a group of papers on modern mineral-prospecting methods, with particular reference to South Africa, Australia and Canada, was presented; and these are strongly recommended for careful study by all who are interested in this important subject[1].

One paper[2] was devoted to the use of aerial photography in the production of geological maps and in the direction of mineral exploration. It is emphasized that photogeology should not be regarded as a substitute for field-work, but rather as a basis for the efficient and economical organisation of field operations. The amount of geological information that can be obtained from photographs of an area will depend mainly on how closely the morphology of the area reflects the structure and lithology of the underlying rocks. Five photogeological maps are given to illustrate what can be accomplished in areas of differing geology and climate.

The methods of mineral exploration now in general use are mainly geological and geophysical, supplemented by an extensive use of test drilling at carefully selected sites. The authors discuss the modern development of these techniques.

In most countries the more obvious mineral deposits have already been discovered, and the modern prospector is faced with the far more difficult task of tracking down deposits that make very little show at the surface or may even be wholly concealed. In some countries, however, notably Canada, there is still place for the older prospecting methods of panning, tracing 'float', noting actual outcrops and mineral stains, etc.; and the present-day prospector is given every assistance by means of courses of study, publications and maps. In the less well-known parts of many Colonial territories, also, there is scope for search along these lines.

In general, however, modern mineral prospecting has to rely on scientific methods of exploration. The production of a geological map—the more detailed the better—and the application of geological knowledge and methods, assisted by aerial survey, geophysics, geochemistry and other new techniques, based upon scientific principles, as auxiliary tools, offer almost the only means of finding new ore bodies.

The geological map is fundamental to any systematic and efficient search for new mineral deposits or for determining possible extensions of known ore-bodies. By means of geological mapping it is usually possible to delineate mineralized areas, and geological mapping provides also the requisite knowledge for the interpretation of the results obtained by geophysical surveying.

The geophysicist has at his disposal four main methods—magnetic, seismic, gravimetric and electrical—in his search for mineral deposits, and the primary object before commencing a survey is to determine, from what is already known about the geology, which method or which combination of methods is most likely to give the desired information. In order to obtain the best results it is essential that the interpretation of the available data is made by the geologist and the geophysicist working in close collaboration. Most geophysical methods do not directly locate ore; they locate structures and formations with which ore is likely to be associated.

Magnetic Method. The magnetic method of prospecting is one of the cheapest and most rapid methods available. It utilizes a natural field of force and depends for its results on detecting variations in the earth's magnetic field occasioned by the presence of magnetic bodies.

In Canadian mineral exploration, magnetic methods have been more widely applied than any other geophysical tool, because they are usually less affected by interfering surface features and because, in general, there exists a broad relationship between rock types and their magnetic properties. Thus, magnetic methods permit a generalized outlining of the rock bodies present, for geological study, deductions and guidance.

Magnetic measurement methods have been applied underground and in drill holes, and the magnetic method is now being practised with air-borne instruments, using both standard and helicopter aircraft.

In Canada the magnetic method has led to the discovery of the Quemont copper gold ore-body, the copper zinc ore-body at East Sullivan, and nickel-copper ore-bodies in Manitoba and elsewhere. In South Africa it was widely applied in the discovery of extensions of the Witwatersrand beds and the new Orange Free State goldfields. It has been used also to delineate post-Coal Measures dykes that have burnt considerable areas of coal on their flanks. It assisted, too, in the discovery of iron ore deposits, in tracing the boundaries of diamond pipes and fissures extending from them, in the investigation of sulphide ore-bodies, and in tracing extensions of the chrome deposits of the northern Transvaal.

During the Second World War the development of the magnetic airborne detector represented an important advance in applied geophysics. This detector, primarily designed to locate submarines by detecting their magnetic field, has now been adopted for magnetometric prospecting. With it, magnetic surveys can be carried out at the speed of the aeroplane, which is of the order of 200 miles an hour. Magnetic surveys can be undertaken over terrain hitherto inaccessible and with an accuracy as great as, if not greater than, that obtained by ground measurements. If the area to be investigated is sufficiently large, the cost per mile of traverse is less than by ground methods. A correct interpretation of the anomalies revealed is, however, dependent on adequate geological knowledge of the area surveyed.

Gravitational Methods. Gravitational methods of surveying involve the measurement of variations in the earth's field of gravitation occasioned by the presence of bodies of density different from that of their surrounding medium. Surveys are made by one or more of the following three methods: (1) pendulum measurements; (2) torsion balance measurements; (3) gravimeter measurements. Of these three, the last two are more commonly used, and the tendency has been in recent years for the gravimeter to replace the torsion balance for many purposes. The time taken to observe one torsion balance station is approximately three hours, whereas the gravimeter, which measures the actual value of the vertical component of gravity at each station, requires only a few minutes to take an observation and is therefore a much less expensive instrument to use. In South Africa, extensive gravitational exploration has been carried out in and around the goldfields of the Orange Free State. Used in conjunction with magnetic methods, which located magnetic bands presumably in Lower Witwatersrand beds, these surveys have, with the help of drilling, discovered the Witwatersrand system, carrying auriferous conglomerates, in an area where there was no single outcrop within sixty miles to indicate what rocks might occur beneath the cover of Karroo beds. Gravitational methods are of great value also in locating faults and in the delineation of major contacts, such as that of the denser portions of the Witwatersrand system with the granite. They were used also to discover possible suitable structures for exploratory drilling in an oil survey.

Seismic Methods. Seismic methods of prospecting are dependent on differences in the speed of transmission of elastic waves through the crust of the earth. The travel-times of waves are observed with seismometers placed at various distances from the shock point. Seismic methods are used mainly in oilfield surveys, but are often used as an adjunct to other methods of mineral exploration. In Canada, seismic work has been almost exclusively confined to determining the depth of drift or depth to basement formations.

Electrical Methods. The application of electrical methods to the direct location of conducting ore-bodies is limited owing to the masking effect of the varying resistivities of the country rock in which the lodes occur. Electrical resistivity methods have

none the less been of use in South Africa as, for example, in locating pyritic deposits developed in schists, schist horizons which carry tungsten, in determining the depth of alluvial tin depths, and the approximate depth of a vermiculite deposit; they are of great value also in ground-water investigations. The self-potential method is probably one of the oldest of geophysical methods and can be employed for the location of certain sulphide ore-bodies. Oxidation, due to contact with underground water, makes the ore-body act as a large galvanic cell with one pole in the upper portion of the body. Considerable potential differences may be set up, and a centre is located in the field which normally lies above the ore-body. In Canada, some of the Noranda sulphide ore-bodies were indicated in this way, as well as a small copper ore-body at Moulton Hill, Quebec.

Radioactivity Measurements. Radioactivity methods of prospecting fall into the category of direct methods since they detect radioactive ores by means of the emanation from the material itself. As a prospecting method, however, this method is restricted, as even the hardest emanation from a deposit of radioactive ore is absorbed by a few inches of barren rock, so that the instruments can only be of use in detecting deposits at or near an exposed surface.

Recent research work by the South African Council for Scientific and Industrial Research has resulted in the development of equipment whereby radioactivity measurements may now be made in bore-holes of a maximum diameter of 1¾ in., using a single-core cable for transmission of the impulses from the counter.

In Canada the radioactivity surveys have been largely confined to prospecting for uranium, and Geiger counters and ionization chambers during the past year alone have directly discovered uranium-bearing occurrences in Ontario, Saskatchewan, the North-West Territories, and British Columbia. This prospecting technique has been applied on the surface, down drill holes, and at Great Bear Lake under 200 ft. of water. Gamma-ray detection by Geiger-type 'Pentron' tube is now possible from an aircraft.

Geochemical Methods. Geochemical methods depend on the micro-analysis of carefully selected parallel samples of soil, humus, rock debris, plant parts, or ground waters for abnormal traces of given elements, such as copper, zinc, lead, gold and beryllium. Analyses may take the form of vapour arc spectra and densitometer measurements, chemical analyses, colorimetric tests, solid residue content, radioactivity, etc., depending on the nature of the problem and the material sought.

Applications of the geochemical technique to ore search are still few in Canada; but research work in this field is active and increasing. Recent research in five important British Columbia metal-mining camps indicates that there is ground for optimism in the application of this technique. V. P. Sokoloff, of the United States Geological Survey, under contract to Zinc Corporation, Ltd., and the Australian Bureau of Mineral Resources, in 1948 carried out extensive geochemical studies in the Wallaroo Moonta area, South Australia, and he used dithizone to detect copper dispersed in the deep residual soils of this mineralized district. The dithizone technique is being applied, too, to the detection of very small quantities of gold above the hæmatite masses of Tennant Creek, Northern Territory, Australia. Geochemical methods are being employed also in Nigeria in the investigation of lead–zinc deposits.

Laboratory services and research also contribute a great deal to modern methods of mineral exploration. In addition to the customary assaying and chemical analyses of mineral samples, ore-dressing and metallurgical research are also undertaken. Moreover, some laboratories are equipped for spectrographical analyses, radioactivity detection and measurement, and X-ray diffraction studies.

Drilling is an essential adjunct to mineral exploration, since the presence of mineral deposits under cover of other rocks, whether inferred from geological or geophysical observations, or by other reasonings, can often be confirmed only by this means. Extensive diamond-drilling exploration, based upon geological and geophysical deductions, has added considerably to our knowledge of ore reserves; in South Africa, for example, the more striking discoveries by this means include the extension of the Witwatersrand gold-field, new gold discoveries near Klerksdorp, the Odendaalsrus gold-field, and a hidden coal-field in the Waterberg district. In Canada, also, drilling in recent years has produced very important results. An unusual mode of diamond drilling, but one quite common in the pre-Cambrian areas of the Canadian North-West Territories, is that of drilling from the ice on frozen lake surfaces. Occasionally lake bottoms are diamond-drilled on the basis of lake-shore float discoveries, or from geological or geophysical observations. Such drilling can be very conveniently and expeditiously performed over a three- or four-month winter period each year.

In addition to drills, several heavy mechanical devices play an important part in mineral exploration. These include bulldozers for surface stripping for purposes of geological study, portable air compressor equipment, and high-pressure pumping equipment for sluicing. In Canada, owing to the vast distances and lack of normal communications, remote mining camps are supplied by Diesel-driven sleigh trains which, in the winter, travel day and night over frozen wastes. At other times equipment is dropped from aircraft on to snow or meadows, sometimes without parachutes.

In one of the papers reviewed, C. J. Sullivan has given a very interesting account of the mineral exploration methods employed in Australia in recent years. In the second half of the last century much important mining activity resulted from discoveries by ordinary prospecting methods; but the rate of discovery of new deposits by such methods in the present century has been quite discouraging. In order to stimulate the search for new mineral deposits by modern methods the Commonwealth Government, besides introducing taxation reforms, has set up the Bureau of Mineral Resources, Geology and Geophysics. The Bureau was created in 1946 and now has an establishment of approximately sixty geologists and sixty geophysicists, as well as small sections devoted to mineral economics, petroleum technology, geochemistry, drilling and mining engineering.

The Bureau is designed to take an active part in mineral exploration, and its programmes of research have been co-ordinated with those of the major exploration companies. The Geophysical Section of the Bureau is the only organisation of its kind in Australia, and it has been responsible for the major portion of the geophysical exploration so far undertaken in that country. It is noteworthy that the discoveries made to date have been almost entirely at or near points where important outcropping mineralization had previously been found by ordinary prospecting methods. The task of extending search

away from known mines has commenced only in the very recent past, and the possibility of the extension of known mineralized structures below thin non-mineralized rock cover is only now being considered.

In the course of the discussion that followed the presentation of these papers, accounts were given of the application of modern methods of mineral prospecting in the British Colonies and in India, and several speakers emphasized that, although applied geophysics is an instrument of great value, a very close collaboration between the geologist and the geophysicist is essential in order to obtain the best results.

F. DIXEY

[1] *C.2.* "Modern Methods of Mineral Exploration in South Africa." By Louis T. Nel, D. J. Simpson and John De Villiers. *C.3.* "Mineral Exploration in Australia." By C. J. Sullivan. *C.4.* "Modern Methods of Mineral Exploration in Canada." By Franc. R. Joubin.

[1] *C.1.* "Aerial Photography in Petroleum and Mineral Prospecting." By A. A. Fitch, D. F. Christie, W. E. Johnstone and G. Whittle.

ANTHROPOLOGY AND ART

By WILLIAM FAGG

THE exhibition of "Traditional Art of the British Colonies" at the Royal Anthropological Institute, 21 Bedford Square, London, W.C.1, which I have had the privilege of arranging, has now been extended until August 4, and is open during 10 a.m.–7 p.m. every day except Sunday. It is perhaps one of the few serious attempts so far made in Great Britain to reconcile in an exhibition the supposedly conflicting disciplines of art and anthropology, and provides a useful occasion to consider whether they are not fundamentally compatible and complementary in much the same way as, for example, religion and science. The great Wilberforce–Huxley controversy of the nineteenth century has long ceased to excite much heat, as divines and savants have equally learned to respect each other's fields; and it is time that artists and anthropologists made the concessions which would enable them to work together for fuller understanding of the highest manifestations of man's genius.

The present exhibition is not a general survey of primitive art, but is confined in the first place to the colonies administered by the British Colonial Office (Australian and New Zealand Colonies being thereby excluded, and with them the magnificent arts of New Guinea and New Ireland); and secondly, with a very few exceptions, to representational as distinct from decorative art, that is, to figures and masks rather than to 'applied' and geometrical carving. The areas represented are therefore the Solomon and Santa Cruz Islands, the New Hebrides in Melanesia, Fiji and, in Polynesia, the Tonga Group; Sarawak, Brunei and Malaya; of the New World Colonies, British Guiana; and, pre-eminently, Nigeria, by far the most fertile in art of all the British Colonies, while the Gold Coast, Sierra Leone and Tanganyika are also represented. An equally good selection might perhaps have been made of works from the French or the Belgian Colonies; but it would have been difficult indeed to raise the standard of quality, however widely the scope of the exhibition had been extended. Apart from a number of pieces lent by the Government of Nigeria, the assemblage is drawn from British private collections, and none of the pieces is therefore accessible in the ordinary way to the British public, though comparable examples of some of the styles might be found in the British Museum.

The purpose of the exhibition is twofold: first, as a contribution to the "Colonial Month", to demonstrate that, in the field of art at least, many of the Colonial peoples have quite as much to teach us as to learn from us, that though they are behind us in material progress, their greater bent for the things of the spirit has enabled them to produce many sculptural masterpieces which equal or eclipse much of the best work of ancient and modern Europe; and secondly, to interest both artists and anthropologists (as well as the art-loving public) in the common ground between them and encourage that collaboration which is essential if some of the most difficult problems are to be resolved.

The problem with which the inquiring viewer of the exhibition will find himself most squarely faced is that presented by the ancient bronzes and terra-cottas of Ife, the religious centre of the Yoruba tribe of south-west Nigeria. He will see, side by side, first, the five terra-cottas (the heads of four men and a ram) recently discovered near Ife, more perfect in their idealized naturalism than almost anything in classical Greece or the Renaissance, and dating probably from the twelfth to fourteenth centuries A.D.; and secondly, a series of wooden masks, still carved and used by the Kalabari Ijo of the Niger Delta, and conveying the idea of the power of the water spirits through a stark and uncompromising stylization. Two styles could scarcely be more diametrically opposed, formally and fundamentally, than these; and it must be said that the Ife style appears distinctly intrusive in the African conception of art. The Ife sculptors sought to present the whole man, perfect by the standards of anatomical mensuration, whereas their successors at Benin and all other Negro tribes (with a few partial exceptions) selected certain qualities and aspects for special emphasis at the expense of the others, and would have thought it inartistic to include matter irrelevant to the idea of a man, or of a spirit, which they wished to present. Thus the Ibo sculptor at Aba who set out to carve the head of an 'elephant spirit' (No. 47 in this exhibition) to symbolize masculine violence and the ugliness of unrestrained power (contrasted with the 'maiden spirit' of gentleness and beauty, in a play on the theme of "Beauty and the Beast") mixed spaces with projecting masses in depth in order to portray that unrelieved ferocity which does not occur in Nature, because every man is a compound of many qualities—good as well as bad—and only art can liberate one from the others. It seems clear that the African artist in general does not entertain the conception of the whole man (as seen at Ife) as an initial stage in working towards his ultimate selective idea of a man; on the contrary, this idea is the very germ and starting point of his creation, with which life-like naturalism has nothing to do.

Here then is the mystery of Ife: Are we to conclude that distortion of Nature not merely is the norm, but is of the invariable essence of 'Africanism' in art—in which case we shall have to regard the Ife sculptures as the products of aliens? Or can we set a limit to racial determinism and admit the possibility that the naturalistic approach and 'intellectual vision' might arise—or be maintained through several centuries after introduction from outside—among Africans if the circumstances were favourable enough? This is a question to which the objective man of science must offer no dogmatic answer; the evidence is inconclusive enough to require him to keep his mind open. Where he fears to tread, the subjective artist may,

however, step in; and my friend Leon Underwood, the sculptor, has propounded the first of the two views in his recently published "Bronzes of West Africa". But the archæologist will have the last word; and my own expectation, on the basis of such evidence as exists, is that, while the initial impulses of the Ife style will prove to have been carried, probably by the Yoruba themselves, from Nubia or thereabouts, excavation will establish that it was developed, and long flourished, in what is now south-western Nigeria.

Mr. Underwood has taken me mildly to task, in a review of this exhibition in *Art News and Review* (July 2), for suggesting in the catalogue of the exhibition that anthropology might help to import some valid objective standards into art criticism. But the art critic does not spurn the help of the laboratory expert who demonstrates that one painting is a forgery and another has been partly overpainted by a later hand, thus saving him from ridiculous discomfiture; he is in equal danger if, in considering primitive art, he ignores the guidance which anthropology can now, and will increasingly, give him. Facts, if properly established, are incontrovertible even by the most gifted of intuitive thinkers. Just as theologists have ceased to maintain, in the face of geology and archæology, that the world was created in 4004 B.C. (in return for the realization by men of science that they can neither prove nor disprove the existence of God), so artists and students of art should acknowledge that they cannot understand, or successfully learn from, primitive art without taking account of its ethnological aspects, and that the same may hold for civilized art at some time in the future, when the necessary techniques have been developed; but anthropologists and allied scientific workers must for their part realize that they cannot contract out of some of the most important and fruitful parts of their field, with the plea that they know nothing about art or have no ear for music, and still claim to be fully trained either in social anthropology or in material culture studies.

NEWS and VIEWS

Biochemistry at Guy's Hospital Medical School: Prof. G. A. D. Haslewood

THE appointment of Dr. G. A. D. Haslewood to the newly established chair of biochemistry at Guy's Hospital Medical School marks a change in the organisation of the teaching of this subject at this Medical School. The new Department of Biochemistry and Chemistry will combine the work formerly carried out in the Department of Chemistry, under the direction of Prof. C. S. Gibson, with the teaching and research in biochemistry, which until now has been a part of the work of the Department of Physiology. Dr. Haslewood received his early training at University College, London. After graduating, he worked with Prof. G. F. Marrian and others at University College during 1931–32 on the constitution of œstriol, as a result of which work they were able to propose a formula for this compound. During this time Dr. Haslewood also isolated a new steroid triol from pregnant mare's urine, and began his career as a teacher. In 1933 he joined the staff of the Research Institute of the Cancer Hospital, London. The preparation of methylcholanthrene from deoxycholic acid was there carried out by Prof. J. W. Cook and Dr. Haslewood. During 1935–39 he was on the staff of the Department of Pathological Chemistry at the British Postgraduate Medical School, where, with Prof. E. J. King and his staff, he worked out a number of microchemical methods for the analysis of blood samples. Throughout this time, he also carried on his work on the chemistry of the steroids, and succeeded in the partial synthesis of 3-β-hydroxy-Δ^5-cholenic acid. In addition, his isolation of 7-hydroxycholesterol from an ox liver extract re-opened the question of the oxidation of cholesterol under biological conditions, afterwards elaborated by Wintersteiner and others. In 1939 he was appointed reader in biochemistry at Guy's Hospital Medical School, since when, in addition to taking over the teaching of biochemistry at this Medical School, he has published papers on the metabolism of cholesterol and the bile acids, and on the excretion of "pregnanediol-like glucuronide" in human urine.

Preventive Medicine at Cardiff: Prof. F. Grundy

DR. F. GRUNDY, medical officer of health to the Borough of Luton, has been appointed professor of preventive medicine in the Welsh National School of Medicine, Cardiff. Dr. Grundy, who is forty-three years of age, held a number of posts as medical officer and medical officer of health, until his appointment to Luton in 1937. All this time, he has shown a keen interest in social and preventive medicine, holding a number of public appointments in this connexion, such as the chairmanship of the British Social Hygiene Council—a position which he still holds. He has carried out important researches in social medicine and published a number of papers on certain aspects of it. Among his books may be mentioned his well-known "Handbook of Social Medicine" which is now recognized as a standard text. He has also travelled to various parts of the world, including the Channel Islands, Sweden, Greece and the United States, for the purpose of studying and advising on health and hospital, maternity and other social services. In expanding its work in connexion with social and preventive medicine, it is doubtful if the Welsh National School could have made a better choice than Dr. Grundy to fill this new chair.

Forestry and Forest Products in South-East Asia: Dr. M. A. Huberman

DR. M. A. HUBERMAN, technical officer in the Forestry Branch, Forestry and Forest Products Division, Food and Agriculture Organisation of the United Nations, has gone to Bangkok, Thailand, headquarters of the Regional Office of the Organisation for Asia and the Far East, where he will act as chief of forestry and forest products. This post will be of great importance in that region in putting into effect recommendations of the forestry and timber utilization conference for Asia and the Pacific held by the Food and Agriculture Organisation in Mysore, India, during March 28–April 8. The importance of forestry is recognized as a prime factor in the raising of living standards throughout the world, and the Mysore conference, at which Dr. Huberman was

secretary-general, was the first meeting of representatives of the countries of the Far East to discuss common problems of forestry and timber utilization. The new post resulted from this conference, which recommended that a forestry and forest products working group be set up in the region, to be composed of staff members of the Forestry and Forest Products Division. The functions of the working group will be, among others, to arrange for exchange of technical and professional information between countries; to arrange for a meeting of technical experts to discuss the standardization of grades and sizes of timber and plywood, nomenclature and trade terms; and to arrange for an exchange of specialists, technicians and students between countries. Dr. Huberman recently travelled through most of the countries of south-east Asia, discussing forestry problems with those officials who are concerned with forest management, trade, soil conservation practices, etc. A graduate of Michigan State College, Dr. Huberman holds a master's degree in forestry and a Ph.D. from Yale University; and before joining the Food and Agriculture Organisation in 1946 he spent fifteen years with the United States Forest Service working in sylvicultural research, private forest management, and national forest administration.

Science Clubs

A PROGRAMME for the stimulation and development of science clubs throughout the world was agreed to at a meeting of science club leaders held in Paris at Unesco House during July 15–16. Representatives from nine countries, meeting under the chairmanship of Dr. Watson Davis, director of Science Service in the United States, agreed to propose that Unesco take steps to recommend to the Governments of Member States that science clubs, which represent a form of activity of general interest, be given effective support. It was suggested that primary and secondary school curricula might be re-examined with the view of reducing, if necessary, the number of compulsory school hours to permit more free time for science clubs. Unesco was also asked to consider the possibility of establishing a permanent central office of information for science clubs. It was also recommended that science clubs concern themselves with the study of scientific method and the social implications of science, and that there be an active link-up with the annual Unesco discussion theme.

Physics Research in Western Germany

THE physical societies of the Western German Zone have issued a memorandum urging political authorities and others not to grudge financial help to places of research. In spite of the well-known fact that 'the physics of to-day is the technology of to-morrow', heavy restrictions have been introduced since the end of the War, and particularly since the currency reform, in the budgets of all university laboratories. Staff has been dismissed and vacant chairs have not been filled. Although Germany has become poor and should be thrifty, it can only live on its output and will soon be considerably poorer still, unless more means than ever before (proportionally) are spent on the re-equipment of its institutes and the training of young scientific workers. The memorandum points out that the number of students in the Western Zone universities has doubled; but science, cut off from the world for many years, has fallen behind and is unable to catch up with other countries for lack of apparatus and materials, so that men of science prefer to work abroad. Modern physics, even if carried on in the least ambitious style, requires very expensive equipment, and the great complication of the work demands more technical as well as clerical staff. "No industrial laboratory works as uneconomically as do the university laboratories, where owing to lack of staff the professors and scientific assistants must do almost all the work themselves." Further, if, as is now the case, one scientific assistant must suffice for a hundred students, both the work of the assistant and the training of the students suffer. The Notgemeinschaft der deutschen Wissenschaft can only supply a small portion of the needed funds, and the universities should have funds of their own, if work is to be undertaken independently of the approval of non-scientific bodies. At present, every trifle must be approved by a Government department and decisions are in consequence greatly delayed.

Photoelectric Spectrometry Group

AT a meeting held in Cambridge on July 16, 1948, the Photoelectric Spectrometry Group was formed with Dr. J. R. Edisbury, of the Research Department of Messrs. Lever, Bros., Port Sunlight, as chairman. Although originally conceived as a discussion group for users of the Beckman spectrophotometer, the scope was later widened to cover other instruments of similar type. Among the activities envisaged were the holding of scientific meetings, the organising of collaborative tests, the maintenance of an accessories pool for the Beckman instrument, liaison with manufacturers of spectrophotometric equipment in Great Britain, and the publication of a bulletin. The first number of the *Photoelectric Spectrometry Group Bulletin* (obtainable from W. H. Storey, Hon. Sec. P.S.G., Unicam Instruments, Arbury Works, Cambridge; pp. 16; price 5*s*.) was issued in April and contains papers by Dr. E. R. Holiday on "Adaptation of the Hilger Spekker Photometer and Medium Spectrograph for Photoelectric Work", Dr. G. H. Beaven on "Notes on the Design, Operation and Maintenance of the Beckman Spectrophotometer" and Dr. J. R. Edisbury on "Relative Readings on Twenty-eight Beckman Spectrophotometers". Several notes on technique and accessories are also included. The Group has now completed its first year of operation and has held four well-attended scientific meetings, membership of the Group now standing at more than one hundred and thirty. The possibility of affiliation to one of the larger existing societies will be given consideration in due course.

Testing Electrical Circuit Breakers

THE Electrical Research Association has recently reported an interesting development which has taken place in connexion with its programme of research on gas-blast circuit breakers. Normally the testing of circuit breakers is carried out using as a power source an alternator having a power rating comparable with that of one of the generators which would feed a power network. An important factor in the behaviour of a circuit breaker in interrupting an alternating current is the rate of rise of voltage across the switch contacts after the extinction of the arc at the instant of zero current; for, if the voltage rises sufficiently rapidly, the gap between the separating contacts may be broken down and the arc re-established for a further half-period. The alternator employed by the Electrical Research Association for circuit-breaker tests is a 6·6-kV., 10,000-kW. machine. It has been found that a

simple circuit in which the alternator is replaced by a charged capacitor imposes upon the circuit breaker a test of almost equal severity to that produced by the machine. In this instance, an experimental gas-blast circuit breaker which has been employed regularly for breaking 1,100 amp. r.m.s. current from the 10,000-kW. alternator was tested on a circuit consisting of a 5-μF. capacitor in series with an inductance of 0·019 H., roughly equivalent to that of the machine, the capacitor having been charged to 10 kV. from a rectifier circuit. The circuit breaker found difficulty in clearing this circuit, although the peak current was only some 130 amp. as against the 1,550 amp. of the machine. The rate of change of current at the end of the first half-cycle is closely similar in the two cases, and the wave front of the re-striking voltage is substantially the same. It is thought that these observations are of significance in relation to the principles of arc extinction and may lead to the development of 'synthetic' methods of circuit-breaker testing.

Work of the United States Naval Observatory

THE results of observations made at the United States Naval Observatory with the 9-in. transit circle during the period 1935·5–1945·2 have been issued as *Publications of the United States Naval Observatory*, Second Series, Vol. 15, Part 5 (Washington, 1948). The programme included: (1) observations of the sun, Mercury, Venus, Mars, Jupiter, Saturn, Uranus, Neptune, 76 day stars, 225 clock stars and 36 azimuth stars; (2) ten observations of each of the stars north of −36° declination contained in a number of specified publications; (3) four observations of each of approximately 800 zodiacal stars fainter than mag. 7·5 contained in the "Albany General Catalogue"; (4) six observations of each of about 3,000 stars, mag. 5·5 to about 8·0, uniformly spaced in the declination zone 0° to −30°; (5) about four observations of each star in a miscellaneous list, including 144 stars of the "International List" for the thirty-ninth parallel, 100 stars of the Washington photographic zenith tube list, and 113 stars, most faint or double stars not in the Yale re-observation of the Astronomische Gesellschaft zone, −10° to −20° declination. A detailed description is given of the personnel, instrumental equipment, general plan of observing, etc. Corrections to the equator and equinox were made, using the sun solutions, Mercury and Venus solutions, and Mars and Jupiter solutions; the results of the solutions of the combined normal equations in each case are given in Table 39. It is expected that the catalogue will represent the results of the last programme to be conducted with the 9-in. transit circle, which has been in service since 1865, but which has been partially dismantled and will be replaced by a new instrument incorporating improved features.

Earthquakes during April

TWELVE strong earthquakes and many minor ones occurred during April. The greatest was probably that which happened on April 25 with strength 7½ and depth of focus 100 km. near the coast of northern Chile. It was felt at Iquique and at Arica and did damage to property in the village of Zapiga. An earthquake, not quite so strong, occurred on April 20 from a focus 70 km. deep in southern Chile, and strongly affected the province of Bio-Bio. There were heavy casualties (at least fifty-seven dead and sixty injured) and property damage at Angol and Traiguen; but other towns and villages, including Chillan, Concepcion and Los Anjeles, were also affected. The next strongest, and certainly the earthquake of deepest focus during the month, occurred on April 5, affecting an area near Vladivostok; the depth of focus was 550 km. On April 13 a shock of instrumental scale just below 7, and with a depth of focus rather greater than normal, caused considerable damage and some casualties over a wide area of the north-west Pacific coast of the United States. The epicentre was between Olympia and Tacoma in the State of Washington. In Seattle, buildings cracked, water mains were broken and two water tanks on the top of business buildings broke, cascading water into the streets. There were also damage and casualties at Portland, Oregon. Five persons have been reported killed and several injured by the earthquake. On April 24 an earthquake caused damage and casualties at Bandär-Abbas on the Persian Gulf. One of the minor shocks of the month happened on April 3 from an epicentre near Mons in Belgium, where it was felt with Mercalli scale 7. This recalls the earthquake of June 11, 1938, with epicentre between Oudenarde and Renaix according to O. Somville. This shock had maximum felt intensity 7 on the Mercalli–Cancani scale and displaced tiles from houses at Herne Bay, Kent. It was felt over a considerable area in Britain. Records have been received from the central stations at Strasbourg, Washington, D.C. (U.S. Coast and Geodetic Survey in co-operation with Science Service and the Jesuit Seismological Association) and Zurich, and stations at Cleveland (Ohio), De Bilt (Holland), Durham, Edinburgh, Kew, Stuttgart and Toledo.

Two New Indian Zoological Journals

FROM India come the first numbers of two new zoological journals, *Indian Journal of Helminthology* and *Journal of the Zoological Society of India*. Both are of the same format, 7½ in. by 9¾ in., of practically the same number of pages, 68 and 70, respectively, and neither contains plates although each is well illustrated by text-figures. The *Indian Journal of Helminthology* was published in October 1948 under the editorship of Prof. Gobind Singh Thapar, who contributes the first paper in it, and it is sponsored by the recently formed Helminthological Society of India (Lucknow: Dept. of Zoology, University. Rs. 5 each issue). Of its six contributions, four are on helminths from fish, one on trematodes from birds and the remaining one on a cercaria from the freshwater snail, *Melanoides tuberculatus*. The cercaria, *C. patialensis*, is remarkable in several respects; *inter alia*, the brevifurcate tail has two processes arising from the region where it joins the body, and it possesses fully formed testes and ovaries with their respective ducts, and even motile sperms. The paper and type are good, and the wide margins give a pleasing appearance in these austere times. The *Journal of the Zoological Society of India* was published in January 1949, under the auspices of the Zoological Society of India (Calcutta), founded in 1939, and while at present it appears half-yearly, it is hoped to produce it quarterly. Its eleven contributions contain the annual address to the Society by Dr. M. L. Roonwall, and papers on fish, free-living and plant-parasitic nematodes, insects and ecology. It is closely printed, in two columns to the page with narrow margins, so that while not so pleasant to read as the other journal, it contains much more material. These journals will furnish additional outlets for Indian zoologists, and we wish them success.

Management for Production

"MANAGEMENT for Production", a pamphlet of 48 pages, price 2*s.* 6*d.*, has been issued by the British Institute of Management to assist in raising productivity. It is based on experience gained in many industries, and most of its suggestions are capable of immediate application and of yielding early results. The ten chapters cover the measurement of work, process planning, the lay-out and organisation of shops, motion study, production planning and control, the maintenance of plant, morale, incentive payments, the control of quality, and costing and control. To all but the second chapter, slender reading lists are appended of somewhat variable quality, but possibly reasonably well adapted to the needs of those to whom this pamphlet is primarily addressed, namely, the small manufacturer and those who have hitherto given little thought to the systematic management of production.

University of London

THE following appointments in the University of London have been announced: Dr. F. W. Jane to the University chair of botany tenable at Royal Holloway College; Dr. C. F. Barwell to the University readership in bacteriology tenable at the London Hospital Medical College; Mr. R. B. Freeman to the University readership in taxonomy tenable at University College; Mr. J. J. Pritchard to the University readership in anatomy tenable at St. Mary's Hospital Medical School; Dr. H. C. Stewart to the University readership in pharmacology tenable at St. Mary's Hospital Medical School. All these appointments date from October 1, 1949.

The title of professor emeritus of anatomy in the University has been conferred on Prof. J. Kirk on his retirement from the S. A. Courtauld chair of anatomy at Middlesex Hospital Medical School, which he has held since 1937.

The degree of D.Sc. has been conferred on D. H. R. Barton (Imperial College).

University of Birmingham

THE University of Birmingham has recently conferred the honorary degree of D.Sc. on Sir Alfred Egerton, Sir Howard Florey, Dr. F. Peyton Rous and Sir Edmund Whittaker.

The following announcements have recently been made by the University. *Appointments:* F. R. N. Nabarro to be research fellow in metallurgy; Dr. H. McManus to be lecturer in mathematical physics; R. H. Dalitz to be research fellow in mathematical physics; Dr. A. B. L. Beznak (formerly professor of physiology in the University of Budapest) to be lecturer in physiology; Dr. C. N. Iland to be lecturer in bacteriology. *Resignation:* Dr. M. Webb, lecturer in chemistry, on appointment as cytochemist at the Strangeways Research Laboratory, Cambridge.

The degree of D.Sc. has been conferred on N. J. L. Megson (chemistry).

Colonial Service: Recent Appointments

THE following appointments in the Colonial Service have been announced. D. L. Downie, botanist, Uganda; T. B. Spence, agricultural officer, Kenya; H. W. Ball, geologist, Nyasaland; D. M. Corbett, veterinary officer, Tanganyika; D. J. Burdon, assistant water engineer, geologist, Water Supply and Irrigation Department, Cyprus; R. J. Garner, assistant meteorologist, Gold Coast; D. K. Jones, agricultural research officer, Cyprus; D. Moore, assistant conservator of forests, Trinidad; H. V. H. Morris, veterinary officer, Windward Islands; M. Greenwood (agricultural chemist, Nigeria), principal agricultural officer, Nigeria; R. J. M. Swynnerton (agricultural officer, Tanganyika), senior agricultural officer, Tanganyika; W. A. McD. Paterson (science master, Queens' Royal College, Trinidad), lecturer in general science (chemistry), Yaba Institute, Nigeria; A. O. Thompson (engineer-geologist, Kenya), geologist, Kenya; J. C. Bytheway (senior produce officer, Department of Marketing and Exports, Nigeria), principal produce officer, Department of Marketing and Exports, Nigeria; L. F. Edgerley (assistant conservator of forests, Mauritius), conservator of forests, Mauritius; R. A. Fitzjohn (sanitary superintendent, Medical Department, Nigeria), mosquito control officer, Nigeria.

The Night Sky in August

FULL moon occurs on Aug. 8d. 19h. 33m., U.T., and new moon on Aug. 24d. 03h. 59m. The following conjunctions with the moon take place: Aug. 7d. 03h., Jupiter 5° N.; Aug. 21d. 05h., Mars 4° S.; Aug. 25d. 19h., Mercury 3° S.; Aug. 26d. 15h., Venus 0·4° S. In addition to these conjunctions with the moon, Mercury is in conjunction with Saturn on Aug. 13d. 14h., Mercury being 0·6° S. Mercury is an evening star, but sets too soon after the sun to be favourably observed throughout the month. Venus sets about an hour after the sun during August and can be seen in the western sky, stellar mag. −3·4. Mars, in the constellation of Gemini, rises after 1h. and is visible during the morning hours. Jupiter, in the constellation of Sagittarius, rises at 19h. 08m., 18h. 08m. and 17h. 02m. at the beginning, middle and end of the month, respectively, but is too low for favourable observation in higher northern latitudes. Saturn sets an hour after the sun on Aug. 1, and less than ten minutes after sunset at the end of the month, and is too close to the sun for observation. Only one star brighter than magnitude 6 is occulted during August, namely, 42 Libr., which disappears on Aug. 2d. 20h. 58·2m. The Perseid meteors are active during the month, attaining a maximum during Aug. 10–12.

Announcements

THE following announcements have recently been made by the University of Leeds. The title of reader in applied geology has been conferred upon Dr. H. C. Versey, senior lecturer in geology. Mr. W. L. J. Potts has been appointed lecturer in mining.

A JOINT committee of the Royal Society and the Armourers and Brasiers' Company has appointed W. K. Honeycombe, of the University of Melbourne and the Cavendish Laboratory, Cambridge, to the Armourers and Brasiers' Research Fellowship for two years from October 1, 1949. Mr. Honeycombe will work on the inhomogeneity of plastic deformation in metals, and the influence of these inhomogeneities on recrystallization and recovery.

ERRATA. Article on "The Chemistry of the Heavy Elements" in *Nature* of June 25, p. 983: (*a*) in the reference to the paper by Haissinsky and Bouissière (p. 983, col. 2, lower portion), the lower valence state of protactinium is believed to be Pa^{4+}, not Pa^{3+}, the reduced material being separable from lanthanum; (*b*) in the discussion of the paper by Bonet-Maury and Leport (p. 984, col. 1, bottom), Haissinsky's comments refer not to polonium, as stated, but to plutonium.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

A New Method of Sampling the Upper Atmosphere

THE accurate determination of composition is an important part of investigations into the upper atmosphere. Until now, the only method has consisted of sending up an evacuated vessel incorporating a device which opens a valve at the appropriate height and later closes it. This method has the disadvantage that vessels of practicable dimensions do not contain much gas, even at atmospheric pressure, and their exterior surfaces are bound to adsorb comparable or even larger amounts; of course, the method becomes still less satisfactory at the high altitudes which are now of interest.

Some time ago, I suggested a new method of sampling, and as it has recently been tried out successfully some remarks about the method may be of interest. The main idea is that a vessel should be sent up, cooled with liquid hydrogen. This arrangement acts as a pump, since the vapour pressures of nearly all the constituents of the atmosphere are negligible at liquid hydrogen temperatures. It is true that hydrogen and helium would not be condensed; but they are present in such minute amounts that they would be rushed into the vessel with the other gases and would be occluded. The superiority of this method would become more and more pronounced with falling pressure. At one-tenth of an atmosphere, for example, such a vessel would condense about 10,000 times as much material as it could take up with the old method.

A few points have to be considered in the practical application of this method, of which two will be mentioned here. First, as it may not be certain that the apparatus is found, after its descent, with the Dewar vessel still intact and cool, the vessel and its automatic valves should be built to stand high pressures. A rough calculation shows that the design of a vessel to stand about 100 atm. would give a good compromise between weight and volume. It would seem quite feasible to build a vessel to take a sample of 50 litres at N.T.P. which would weigh about 2 kgm. Secondly, precautions have to be taken to avoid a hydrogen gas 'block' in the mouth of the vessel due to the evaporation of hydrogen during condensation of the air. This can be effected, for example, by attaching a tube of sufficient length to the intake of the apparatus or to the outlet of the Dewar.

I was originally mainly interested in investigating the abundance of helium-4 and helium-3, and tests at very high altitudes would be needed to get results of significance. Rockets able to penetrate into the interesting region are not available in Great Britain, nor are pilot balloons able to reach heights above 25 km. In order to start these experiments we have therefore concentrated at first on the determination of water in the atmosphere. This is a matter of great interest to meteorologists, and significant results can be obtained at relatively low altitudes. The Gassiot Committee of the Royal Society allocated to us last year the necessary funds, and Mr. Peckover and I have built a first model with hand-operated valves which can be used in an aeroplane. Mr. Peckover has recently been able to take this apparatus up to a height of 6 km., thanks to the kind co-operation of the Meteorological Research Flight R.A.E. Station, and has successfully taken a sample of 50 litres at N.T.P.; these experiments will be extended to higher altitudes, and we shall report on the results in due course. We are now designing, with the experience gained, an automatic apparatus to be used with pilot balloons. It should be emphasized, however, that the main field of application of the method would be its use in conjunction with rockets, where, incidentally, limitations of weight are much less severe and a series of samples at varying heights could be collected.

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June 15.

Production of Ice-Crystal Clouds by Seeding

FOLLOWING Schaefer's cloud-chamber experiments[1] on the formation of ice crystals in supercooled water-droplet clouds by localized cooling, Langmuir has noted the possibilities of producing ice-crystal clouds on a large scale, and has observed the sudden formation of a veil of ice-crystals 600 ft. below a seeded cloud, caused by the passage of 'dry ice' pellets[2].

During a series of induced precipitation experiments in Canada, this generation of ice-crystal clouds in clear atmosphere through the action of 'dry ice' was also observed, and it was thought that it offered an excellent experimental method of observing the immediate full-scale results of 'seeding' with various agents and techniques, without the visual interference of a cloud, or the space restrictions of a cold chamber. In addition, the complication of the presence of supercooled water droplets was removed, leaving only the change from water vapour to ice crystals to be studied. This latter feature would be very useful, for example, in observing the action of silver iodide as a seeding agent. Accordingly, during the latter part of the past winter, whenever clear air was found that was supersaturated with respect to ice but not to water, the opportunity was taken to seed it, using 'dry ice'.

On each occasion when the air was measurably supersaturated, ice crystals have been formed by seeding. About one minute after the 'dry ice' has been dropped (usually from a few hundred feet above, or from inside, the supersaturated layer), and so some appreciable time after its cooling influence, a faint 'vapour trail' would become visible, which developed rapidly within the next minute into a vertical curtain of ice crystals. This curtain appeared to be composed of a very large number of individual vertical streaks, each of which seemed to grow downwards erratically and jerkily as regards both speed and direction, although the curtain as a whole developed with reasonable uniformity. While the immediate impression was of some form of chain reaction, it is more likely that the effect was caused by the crystals becoming visible at a fairly definite interval of time after the passage of the 'dry ice' granules, which were irregular in shape and size.

The length of the curtains depended on the length of seeding run, usually two to three miles. The depth, some 500–2,000 ft., seemed to depend on some factor

other than the depth of the humid layer. The width was negligible.

Immediately after formation, the ice crystals began to rise, presumably due to latent heat release. In most cases the humid layer occurred under a temperature inversion and the curtain then rose and flattened out under this within a few minutes. The cloud thus formed would be some 1,000 ft. wide and up to 500 ft. deep and would persist until out of sight, not appreciably increasing in volume, but appearing to become denser with time; this suggests considerable growth of the individual crystals at the expense of the surrounding air, made possible by small-scale turbulence at the edges. So far, none of these generated clouds has been observed for more than twenty minutes after seeding.

By using a cloud-droplet camera in the aircraft, photographs have been obtained of the generated ice crystals. From such photographs it has been possible to make some preliminary studies of the growth of the generated crystals, and to compare them with ice crystals in adjacent natural clouds.

Some preliminary tests on the effect of rate of seeding, of size of 'dry ice' granules, and other seeding variables have also been made, attended, however, with some difficulty, as there is evidence that a considerable and uncontrollable variable may be local variations in humidity, on a scale suggested by the incidence of natural clouds of this type, which are generally very patchy.

As a footnote on the possibilities of interference with Nature, it is interesting to observe that just as success in inducing precipitation seems to require conditions where natural precipitation could well occur anyway, so every time clouds have been generated, natural clouds (or haze) have formed at about the same time and place.

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March 21.

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Formation of Frozen Rain-drops and the Condition of Ice-crusted Trees

In districts of high latitudes, it is often found that the central portions of fine suspended water-drops remain unfrozen, even though the temperature of the water is cooled down to $-20° \sim -30°$ C. This curious phenomenon can be explained by means of my theory of transformation stress; there is an outer spherical crust of ice and an inner water core, the freezing beginning from the outside and proceeding towards the centre. By applying this system of two spheres to the case of the freezing of water, we obtain for the mean intensity of pressure and for the depression of freezing point the following values:

$$0{\cdot}355\,K\,\frac{\delta v}{v} = \bar{p} = 3{,}280 \text{ atmos.}$$

and

$$\Delta T = 0{\cdot}355\,KT\left(\frac{\delta v}{v}\right)^2/\rho\lambda = -26{\cdot}4° \text{ C.}$$

In these expressions for $\bar{p}$ and ΔT, $K = 1{\cdot}03 \times 10^{11}$, $T = 273$, $\rho = 0{\cdot}91$, $\lambda = 80 \times 4{\cdot}2 \times 10^7$, $\frac{\delta v}{v} = 0{\cdot}09$ (to be published in the near future). The observed value of ΔT is $-33°$ C., in fair agreement with the theoretical value. Thus, during freezing, the surface of the inner sphere of water may sustain a mean pressure of 3,280 atmospheres at $-33°$ C., and therefore below this temperature the water remains as such. This provides an explanation of frozen rain-drops.

Next, take the case of ice-crusted trees. The water penetrates into the inner portions of tree branches, leaves, etc., and freezes into ice; but the water in the central portion remains as such, owing to the high pressure of the surrounding ice. Hence, even in very cold weather, the translocation of the necessary water from roots to leaves of these trees is not very much prevented, and so the damage is not very great.

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Dec. 26.

Biosynthesis of 'Asymmetric' Citric Acid: a Substantiation of the Ogston Concept

A. G. Ogston[1], in a recent note in *Nature* on the "Interpretation of Experiments on Metabolic Processes, using Isotopic Tracer Elements", introduced the important concept that an enzyme might be able to distinguish between the chemically 'identical' groups of a symmetrical compound. Ogston pointed to the dangers of the contrary assumption, and as one example he questioned the conclusion that citric acid was not an intermediate in the Krebs cycle of oxidations in so far as this conclusion was based upon the finding that the fixation of isotopically labelled carbon dioxide led to the formation of asymmetrically labelled α-keto-glutaric acid. It had been assumed[2,3,4] that if citric acid were on the pathway leading to α-ketoglutaric acid, the latter would have had isotopic carbon equally distributed between the two carboxylic acid groups.

We have tested the Ogston concept as it applies to this case. Carbon dioxide labelled with carbon-14 was released into the gas phase of Warburg flasks containing a reaction mixture in which a rat-liver homogenate was oxidizing oxalacetate and pyruvate under conditions that lead to the accumulation of citrate[5,6]. Citric acid containing carbon-14 was isolated using a silica gel column according to the method of Isherwood[7] as employed by Stutz and Burris, of the Biochemistry Department at this University. The citric acid (a structurally symmetrical molecule) was enzymatically converted to α-ketoglutaric acid in the presence of 0·0003 *M* arsenite by means of a preparation derived from a rat-liver homogenate[8]. The α-ketoglutaric acid was converted to the 2,4-dinitrophenylhydrazone, and this was purified by passage through a column of diatomaceous earth according to the method of LePage[9] to separate it from any possible pyruvate and oxalacetate hydrazones. It was then mixed with pure non-radioactive α-ketoglutarate dinitrophenylhydrazone and recrystallized five times. The product was oxidized to succinic acid and carbon dioxide using potassium permanganate as described by Krebs[10], and carrier succinic acid was added to the reaction mixture and isolated and purified by recrystallization.

The results of a typical experiment are as follow :

Compound	Total radioactivity per Warburg flask (counts per minute)
Citrate	11,300
α-Ketoglutarate dinitrophenylhydrazone	2,550
Carbon dioxide from ,, ,,	2,470
Succinate from ,, ,,	< 70

It is apparent that the α-ketoglutaric acid was labelled solely in the carboxyl group adjacent to the carbonyl group. Hence, as revealed by enzymatic means, the citric acid must have been labelled exclusively in one of the two 'identical' carboxyl groups. These data thus fully substantiate the concept set forth by Ogston[1] relative to the experiments that were earlier used to eliminate citric acid from the Krebs 'citric acid cycle'.

It is interesting to note that the recent data by Stern and Ochoa[11] on the biosynthesis of citric acid are now seen to be compatible with the data of the earlier tracer experiments[2,3], although incompatible with the conclusions drawn from them.

It is a pleasure to acknowledge our gratitude for the assistance of Profs. R. H. Burris and G. A. LePage, Dr. R. E. Stutz, Mr. L. S. Watson and Mrs. G. G. Lyle in carrying out these experiments.

This work was supported by a grant from the American Cancer Society on the recommendation of the National Research Council Committee on Growth, and by a grant from the U.S. Public Health Service.

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June 7.

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[9] LePage, G. A. (unpublished).
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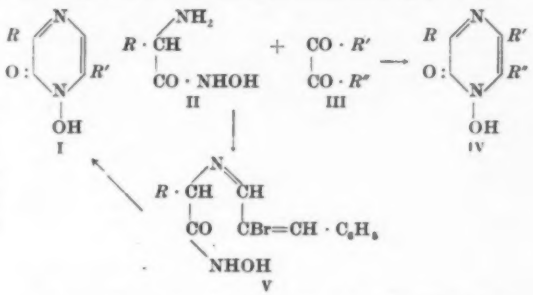
Synthesis of Pyrazine Cyclic Hydroxamic Acids Related to Aspergillic Acid

Aspergillic acid is a pyrazine cyclic hydroxamic acid of structure (I). Although a general method has been developed for the synthesis of pyridine and quinoline cyclic hydroxamic acids[1], attempts to apply this method in order to effect a synthesis of a pyrazine cyclic hydroxamic acid have been unsuccessful, peroxidation of a 2-substituted pyrazine giving the 4-oxide and not the required 1-oxide[2]. We now describe two syntheses of pyrazine cyclic hydroxamic acids starting from α-aminohydroxamic acids (II), which are readily obtained by the action of hydroxylamine on α-amino-esters.

Condensation of α-aminohydroxamic acids (II) with 1 : 2-dicarbonyl compounds (III) gives pyrazine cyclic hydroxamic acids (IV). The properties of the acids (IV) closely resemble those of aspergillic acid. In particular, they give a strong ferric reaction and, on reduction with hydrazine, each is converted into a hydroxypyrazine identical with the corresponding hydroxypyrazine obtained by the condensation of an α-amino-acid amide with a 1 : 2-dicarbonyl compound[3]. Using a 1 : 2-keto-aldehyde such as methylglyoxal (III, $R' = Me$, $R'' = H$) or phenylglyoxal (III, $R' = Ph$, $R'' = H$) as the dicarbonyl component, the reaction gives a 3 : 5-disubstituted cyclic hydroxamic acid (IV, $R' = Me$ or Ph, $R'' = H$) exclusively and not the isomeric 3 : 6-disubstituted acid (IV, $R' = H$, $R'' = Me$ or Ph). Considerable changes in the reaction conditions did not vary this experience ; consequently the method will not serve for a synthesis of aspergillic acid (I).

A suitable method for the synthesis of a 3 : 6-disubstituted pyrazine cyclic hydroxamic acid has been developed. Glycine hydroxamic acid (II, $R = H$) reacts with 2-bromocinnamaldehyde to give



the Schiff base (V, $R = H$) which, on treatment with sodium alkoxide, gives the cyclic hydroxamic acid (I, $R = H$, $R' = CH_2Ph$). Similarly, treatment of 2-bromocinnamaldehyde with α-amino-*n*-butyrohydroxamic acid (II, $R = Et$) gives the Schiff base (V, $R = Et$), which is cyclized by treatment with potassium *t*-butoxide to give 1-hydroxy-2-keto-3-ethyl-6-benzyl-1 : 2-dihydropyrazine (I, $R = Et$, $R' = CH_2Ph$). This method, or a simple variant, offers a route to the synthesis of aspergillic acid. The method is attractive in that it allows the introduction of different substituents at the 3- and 6-positions, a feature which will be of value in deciding between the alternative formulæ (I, R = *sec.*-C_4H_9, R' = *iso*-C_4H_9) and (I, R = *iso*-C_4H_9, R' = *sec.*-C_4H_9) for aspergillic acid.

George Dunn D. W. C. Ramsay
J. A. Elvidge F. S. Spring
G. T. Newbold Wilfred Sweeny
Royal Technical College,
Glasgow. June 16.

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Fractionation of Thyroid Iodine by means of Filter-Paper Partition Chromatography

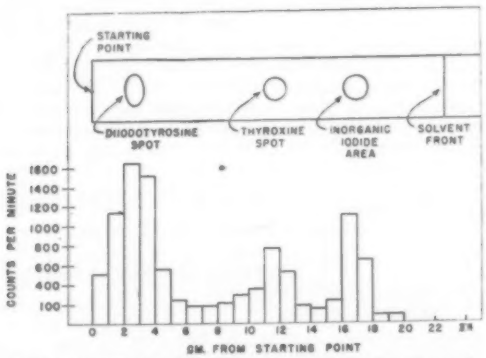
By means of filter-paper partition chromatography, Fink, Dent and Fink[1] located several different radioiodine fractions in hydrolysates prepared from thyroids of rats that had been injected 24–28 hours earlier with iodine-131. Surprisingly, little or none of the radioactivity was found as thyroxine. Since this is not in accord with previous results from this laboratory[2], we examined the method of filter-paper chromatography as applied to thyroid iodine.

Rats were injected with approximately 50 μc. of iodine-131, and sacrificed twenty-four hours later. Their thyroids were removed and ground in a small, all-glass homogenizer with 1 c.c. of cold, 10 per cent trichloroacetic acid[3]. The precipitate, containing the organic iodine, was washed with trichloroacetic acid and hydrolysed for 16 hours, with 1 c.c. of 2*N* sodium hydroxide, on a steam bath. The hydrolysate was not neutralized before it was added to the paper. Attempts to neutralize it, even partially, always resulted in undesirable precipitation. The addition of 20 μl. of the strongly alkaline hydrolysate (in two portions of 10 μl. each) did not seem to damage the filter paper excessively.

Chromatograms of the single-dimensional, ascending type were made. The solvent mixture was composed of 100 parts collidine and 44 parts distilled water. An ammonia atmosphere was found desirable.

Crystalline thyroxine and diiodotyrosine (15–20 μgm.) were added to the hydrolysates before chromatographing, and their positions on the filter paper were located by spraying with diazotized sulphanilic acid. The latter reagent is more suitable than ninhydrin since, under the conditions used here, it gives a noticeable colour only with the added thyroxine and diiodotyrosine. The position of inorganic iodide was determined by adding an excess of iodide iodine-131 to a separate portion of the hydrolysate, and running it alongside the regular chromatogram.

When dry, the chromatograms were marked off in 1-cm. sections, and the activity in each section was determined with an aluminium-wall Geiger counter placed behind lead bricks arranged so as to expose a slot 1 cm. wide. The paper was held in place with rubber bands and moved along manually at 1-cm. intervals.



Distribution of radioactive iodine in chromatogram prepared from 2*N* sodium hydroxide hydrolysate of rat thyroids. Diagram of the chromatogram directly above the curve shows the correspondence between the peaks in the activity and the known positions of diiodotyrosine, thyroxine and inorganic iodide

The results of a typical experiment are shown in the accompanying diagram. The peaks in the radioactivity of the hydrolysate correspond very closely to the positions of diiodotyrosine, thyroxine and inorganic iodine. The respective R_F values of these three iodine compounds, under the conditions used here, were 0·12, 0·52 and 0·73. Appreciable amounts of radioiodine, corresponding to none of the iodine compounds listed above, were also present, a finding in accordance with the observations of Fink, Dent and Fink.

The results in the diagram show that approximately 15 per cent of the iodine-131 of the gland is located in the vicinity of the thyroxine spot. Although this value is lower than that observed by us when the standard butyl alcohol fractionation procedure is used[2], it nevertheless represents an appreciable amount of thyroxine formation. The finding of a large amount of iodine-131 in the inorganic fraction suggests that an appreciable breakdown of organic iodine occurs during the hydrolysis, since the inorganic iodine-131 initially present in the tissue had been removed by treatment with trichloroacetic acid.

In order to minimize the breakdown of organic iodine compounds, hydrolysis of thyroid tissue with 8 per cent barium hydroxide was investigated. Under such conditions, almost all the thyroxine became insoluble. No thyroxine spot appeared even when 15 μgm. of crystalline thyroxine was added to the hydrolysate. If, however, the hydrolysate, along with the added thyroxine, were adjusted to *p*H 3·5–4·0 and extracted with butyl alcohol, both chemical and radioactive thyroxine could be demonstrated in the butanol extract. The insolubility of thyroxine in a barium hydroxide hydrolysate may account, at least partially, for the failure of Fink *et al.* to find appreciable activity in the thyroxine fraction.

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Dec. 8.

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Use of Furan Derivatives in Paper Chromatography

THE separation of mixtures of amino-acids into discrete spots on paper chromatograms has hitherto almost invariably been carried out using solvents only partially miscible with water. However, in work concerned with the separation of certain peptides we found that the usual solvents (namely, butanol, benzyl alcohol, phenol, collidine) were inadequate, and in consequence sought alternative solvents.

Consden, Gordon and Martin[1] stated that liquids totally miscible with water could be used provided the water content was not too high, but that when these solvents were used for irrigation of paper chromatograms the amino-acid bands were too broad for practical use. Our first observations were in agreement with this. Acetone and certain three-component systems containing water and organic solvents with the addition of organic or mineral acids all produced long 'streaks', usually extending the whole length of the paper.

We have found, however, that furfuryl alcohol and tetrahydrofurfuryl alcohol containing water (10–30 per cent v/v) give good separations of amino-acids on paper chromatograms. The spots obtained are small, sharply defined with very little 'tailing' and comparable in every way with those obtained using the usual solvents. The actual magnitudes of the R_F

values of the amino-acids, but not the order, vary with the amount of water present in the irrigation solvent, increasing with increasing water-content while the range of values decreases. We have used furfuryl alcohol containing up to 80 per cent water. At this high level there is, of course, very little, if any, separation of the amino-acids, and the bands are very broad; but at 60 per cent water-content there is some differentiation of R_F values and the bands are reasonably compact. The optimum water-content is 20–30 per cent, and 25 per cent is convenient for general use.

Amino-acid	—	Urea (0·5 per cent)	Pyridine (8 per cent)	Furoic acid (5 per cent) Urea (0·5 per cent)	Tetrahydrofurfuryl alcohol
Aspartic acid	0·18	0·20 B	0·07	0·23	0·15
Glutamic acid	0·18	0·23 P	0·09	0·33	0·19
Cystine	0·16	0·19 G	0·06	0·11	0·20
Serine	0·20	0·29 P	0·14	0·26	0·34
Glycine	0·21	0·28 Br	0·15	0·29	0·28
Ornithine	0·24	0·28 P	0·10	0·24	0·31
Arginine	0·24	0·32 P	0·17	0·32	0·27
Histidine	0·25	0·39 Br	0·22	0·31	0·31
Lysine	0·25	0·20 P	0·13	0·28	—
Alanine	0·34	0·39 PB	0·26	0·47	0·43
Threonine	0·31	0·34 P	0·22	0·37	0·46
Hydroxyproline	0·35	0·41 Y	0·32	0·43	0·39
Tyrosine	0·46	0·47 G	—	0·52	—
Valine	0·50	0·52 BP	0·43	0·64	0·64
Methionine	0·55	0·58 P	0·42	0·59	0·67
Proline	0·56	0·56 Y	0·42	0·61	0·49
Norvaline	0·56	0·56 P	0·38	0·61	0·63
Tryptophan	0·56	0·59 GP	0·43	0·61	0·70
Leucine	0·59	0·63 P	0·43	0·69	0·72
Isoleucine	0·59	0·63 P	0·43	0·70	0·71
Phenylalanine	0·63	0·64 GP	0·52	0·72	0·73

Colours given by ninhydrin, blue (B); brown (Br); grey (G); purple (P); yellow (Y). If the paper is dried at too high a temperature, particularly with furoic acid, brown stains appear in the area of the spots, which then fail to develop the characteristic colorations.

Commercial tetrahydrofurfuryl alcohol can be used without further purification; but furfuryl alcohol must be freshly distilled before use, since the clarity of the final chromatogram picture is seriously impaired if the solvent has acquired a yellow coloration. The inclusion of urea (0·5 per cent) as a stabilizer[2] sharpens the outlines of the spots and reduces their size, and a similar improvement is given by pyridine (8 per cent v/v). Furoic acid (5 per cent) has also been added. These additions give useful variations in R_F values which are set out in the accompanying table. The values given are for furfuryl alcohol – water (25 per cent v/v) with the additions stated, and for tetrahydrofurfuryl alcohol – water (20 per cent v/v). Using Whatman No. 4 paper (18½ in. × 22 in.) in apparatus measuring 30 in. × 30 in. × 5 in. these solvents run to a distance of 30–40 cm. in eight hours.

Furfuryl alcohol – water has also been employed for the separation of amino-acids on starch columns, good separations being obtained of proline from aspartic acid and of phenylalanine from alanine. Preliminary work has also indicated the value of these new solvents in the separation of sugars on paper chromatograms.

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[1] Consden, R., Gordon, A. H., and Martin, A. J. P., *Biochem. J.*, **38**, 224 (1944).
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Quantitative Paper Chromatography

We have read with interest Mr. R. C. Brimley's letter in *Nature* of February 5, p. 215. There are two points at which its treatment requires to be amplified. In the first place, he appears to assume diffusion to be the sole agency distributing the substance of the spot around its centre, and ignores entirely the effect of partition of the substance between aqueous and non-aqueous phases. The elementary theory of partition chromatography[1] or of counter-current extraction[2] leads to the expectation that, even in the absence of diffusion, a substance originally located within the confines of a single 'plate' of the chromatogram will, when the chromatogram is developed, be distributed through all the plates of the chromatogram in accordance with a binomial distribution of high index, which can be approximated by a normal distribution along the direction of flow.

Since partition chromatographic spots are usually markedly elliptical, rather than circular as required by Mr. Brimley's equations, it is obvious that the second factor is an important one, and that, in the absence of allowance for it, it is improper to compute errors theoretically.

Our original rather cryptic reference to errors[3] applied to an assay technique which we were in course of developing. Briefly, the procedure of assay is to develop four spots in parallel containing amounts s_1, s_2, u_1 and u_2 of the component to be assayed, where the s's are known and the u's are unknown, and where $s_1/s_2 = u_1/u_2 = k$. If the corresponding areas of spots on the developed chromatogram are S_1, S_2, U_1 and U_2, then the logarithmic relation gives:

$$\log \frac{u_1}{s_1} = \frac{(U_1 + U_2) - (S_1 + S_2)}{(U_1 - U_2) + (S_1 - S_2)} \log k.$$

Present evidence, which we hope to publish in full shortly, suggests that the accuracy foreshadowed in our earlier communication can be achieved by this means.

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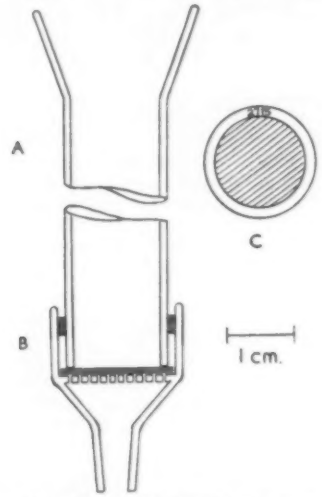
Preparation of Silver Bromide Precipitates for Radioactivity Measurements

Radioactive tracer studies in progress at this Laboratory employing insecticides labelled with bromine-82 have involved activity measurements on liquid and solid samples, and on gaseous samples in certain cases. Liquid samples (usually as soluble bromide) were assayed in a Geiger–Müller counter of the type described by Veall[1], whereas solids (usually as silver bromide) were assayed under a thin mica end-window counter of conventional design. For bromine-82 activities ($E_{\beta\text{-max.}} = 0{\cdot}46$ MeV., $E_\gamma = 0{\cdot}55$, 0·79 and 1·35 MeV.) the use of liquid samples proved the more convenient; but that of prepared precipit-

ates was some fifteen times more efficient. The higher efficiency was a decisive factor with samples of low specific activity.

For precise measurements of solid activities depending upon moderate- or low-energy β-emission it is necessary to prepare solid samples in a geometrically uniform and reproducible manner. This has been accomplished by evaporating a suspension of the precipitate (for example, BaS^*O_4) in a shallow cup, or by collecting the precipitate (for example, BaC^*O_3) on a specially mounted filter paper[2,3,4]. The evaporation technique has the disadvantage of necessitating a preliminary separation from unwanted soluble matter. Filter papers have the disadvantage of variable texture, and variable weight due to moisture absorption, etc. The following technique developed for $AgBr^*$ precipitates combines the convenience of precipitation and filter paper collection, and the advantage of mounting on a permanent metal disk which lends itself to precise weighing and handling without fear of damaging the precipitate.



Preparation of silver bromide precipitates for radioactivity measurements

The soluble bromide (including added carrier) is precipitated as silver bromide (10–50 mgm.) and coagulated by rotation. One drop of 'Teepol' wetting agent is added and the suspension transferred to the thick 'Pyrex' tube (*A*), which is very firmly and vertically clamped down on a Whatman No. 50 filter circle backed by two Whatman No. 4 circles (punched to a diameter of 1·75 cm.) resting inside the small Buchner funnel (*B*). Suction from a filter pump is controlled by means of a three-way tap. The collected precipitate is finally washed with acetone and has an area of 1·50 cm.². The tube is gently removed, leaving the precipitate as a uniform moist circular disk exactly centred on the top filter paper. The three papers and precipitate are placed on an aluminium tray, precipitate upwards, and a tared 'Alkathene'-faced lead disk (*C*) placed, 'Alkathene' downwards, exactly on top of the precipitate. A solid flat-ended brass cylinder (diameter, 1·35 cm.) at 140° C. is then pressed squarely on top of the lead disk and held for a second or two. This treatment immediately dries off residual acetone, and the thermoplastic softens sufficiently to bind the base of the precipitate. The whole is then reversed, and the filter papers can be cleanly peeled away, leaving the precipitate as a hard flat disk. Silver iodide and silver chloride behave similarly. The disk and precipitate are weighed, mounted on a specially designed brass carriage and adjusted below the counter window to within 0·025 mm. Lead is employed deliberately to enhance back-scattering[5].

The compound disks are prepared by hot-pressing punched 'Alkathene' circles (1·40 cm. × 0·025 mm.) on to lead disks (1·75 cm. × 0·18 mm.) punched from cleaned lead foil. The mounted precipitates are kept in a darkened desiccator. Serial numbers are scratched between the edge of the precipitate and circumference of the lead disk.

In a series of twenty assays of a solution of active bromide over a period of about three half-lives (3 × 34 hr.), the overall coefficient of variation was ± 1·8 per cent on total counts of 10^4. The precipitate thicknesses varied from 6·2 to 43·7 mgm./cm.². Corrections were made for decay, self-absorption, dead-time, etc. Full details of the technique will be included in a paper to be published elsewhere. This letter is published by permission of the Department of Scientific and Industrial Research.

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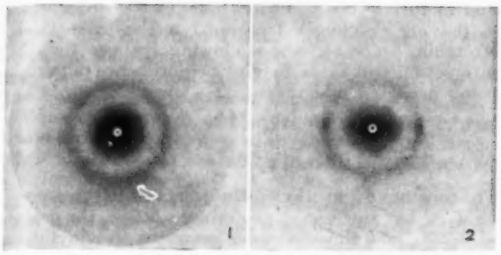
Denaturation in Regenerated Protein Fibres

In a discussion on the possibility of producing a regenerated keratin fibre, Mercer[1] claims to have retained the α-form of the molecule in wool reconstituted from solution. This is a matter of some interest, as the yarns produced by Dr. R. L. Wormell[2] and myself show no evidence of the α-keratin structure even in orientated fibres. During the past few months, highly orientated specimens of casein yarn have been made[3] which may throw some light on Mercer's results, especially with reference to the type of solution from which fibres are drawn containing an α-keratin phase. Fig. 1 is an X-ray photograph of a Ferretti-type casein fibre which shows little or no obvious orientation by X-rays. Fig. 2 is an X-ray photograph of highly orientated casein which is, in the main, made up of reflexions from a two-phase system. First there is the X-ray photograph of a normal β-protein type of fibre comprising an axial repeat of 3·25 A., a backbone spacing of 4·65 A., and a side-chain spacing of approximately 10·5 A. Superimposed on this diagram, however, there is a strong polar arc of 4·65 A., which is most probably indicative of a protein phase containing a crystalline cross β-configuration of the molecule.

The demonstration by Mercer of the presence of the α-fold is not in accordance with what might normally be expected in protein fibres regenerated from solution. This specificity implies in the reconstituted α-protein a lattice similar to that produced in the original biological synthesis. A possible explanation of the result is given in the following discussion,



X-ray photograph of: (1) Ferretti-type casein fibres, showing an apparent disorientation of the β-protein structure; (2) highly orientated casein fibres, showing the presence of a highly orientated normal β-protein type diagram, and also a polar arc of 4·65 A. characteristic of the cross β-pattern. Copper $K\alpha$; $D \approx 2{\cdot}1$ cm. (reduced from 4 cm. on reproduction)

and fits readily into the general scheme of the structure of regenerated protein fibres. The theory does not demand reproduction of the molecular specificity on recrystallization from solution, and, in particular, the mechanism of regeneration is comparable with that of casein, where difficulties have been encountered in the past in producing a highly orientated and stable fibre. Casein (and groundnut globulin) fibres cannot be made, at least at present, with tenacities much greater than about 1·3 gm./denier, and it is suggested that the reason for this is as follows. Only certain casein molecules are denatured in solution and reconstituted as an aligned β-protein lattice (Fig. 2). A second phase is probably still retained as partially denatured molecules in solution, and these when spun tend to form up as elongated globular proteins retaining part of, or all, their original specific form. If this is the case, then casein, which from the very nature of its functional properties must be a very complex mixture of structurally variable protein molecules, is not completely denatured during solution for spinning. On normal regeneration, orientation may be difficult to discern as the strong 4·65 A. polar and equatorial reflexions tend to overlap, causing this 'backbone spacing' to appear as a continuous ring. The X-ray photograph of a highly orientated sample, however, shows the reflexions resolved, and the two phases may be identified. One criticism which might be applied to this theory of partial denaturation of the casein molecules is that an assumption has been made that the cross β-pattern arises from molecules which have not been denatured. It is possible that the denatured molecules themselves collapse in solution into a new form with the typical cross β-fold at right-angles to the long axis of the molecule. Such a condition, however, even if it did obtain, would not vitiate the general thesis of the discussion, as such molecules would not be in a fully extended β-configuration and would, in consequence, occur as elongated globules capable of forming a second phase in the casein fibre. This explanation is, however, less likely, since during manipulation extension is applied to the casein yarn at all stages; but there is no evidence from the X-ray photographs that the crystalline cross β-pattern is being readily pulled out into the fully extended β-form.

In the case of Mercer's work, the α-form which is obtained in drawn fibres is probably from protein which is not denatured in the solvents and which can be orientated in a matrix of soluble protein in a manner somewhat similar to that suggested for highly orientated casein fibres. The probability of the presence of molecular aggregates sufficiently large for the retention of the α-form in some of the dispersed keratin is indicated by the results from the ultracentrifuge. It will be interesting to note whether the possible presence of these two phases will tend to inhibit the spinning of this material; but if the system is similar to that in casein, then it is not likely to cause much trouble. On the other hand, a fibre made by this method may probably have an ultimate strength limited by the lack of uniformity in the two phases present. If, however, the proteins have been sufficiently dispersed in solution to assure complete denaturation, then it is clear that a specificity built up in a protein during biological synthesis has been reproduced to some extent by the interaction of the protein with itself and its artificial environment. Lastly, if the protein has been only partially denatured, then a mixed α- and β-keratin diagram might be expected on the X-ray photograph of a highly orientated sample of Mercer's fibres, in contradistinction to those of Dr. Wormell and myself, which have not as yet yielded a diagram showing the typical reflexions of α-keratin.

Note added in proof. Since this article was written, it has been shown that certain polypeptide molecules may fold into stable configurations which appear similar to α-keratin[5]. It is possible, therefore, that Mercer's results may be explained in part along these lines; but in our more recent work on keratin, we have been unable to identify an α-structure in the regenerated wool fibres.

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Sodium Bismuthate as an Oxidizing Agent for Organic Compounds

1 : 2 GLYCOLS are oxidatively cleaved to carbonyl compounds by sodium bismuthate in an acid medium, the reagent thus behaving in a similar way to periodic acid[1] and lead tetra-acetate[2]: α-hydroxy acids are degraded to the lower aldehydes.

Two principal methods of experiment have been used. (*a*) The reagent was added to a solution of the glycol in glacial acetic acid and stirred or shaken at, or slightly above, room temperature, until the colour was discharged and a clear solution resulted (taking a few minutes or several hours); this procedure is also suggested as a convenient test for these classes of organic compounds. (*b*) The reaction was similarly carried out with the glycol in aqueous (purified) dioxan solution in the presence of phosphoric acid, the initially yellow-orange suspension being ultimately replaced by pure white bismuth phosphate. Commercially available sodium bismuthate with an oxidizing capacity (towards ferrous sulphate) equivalent to 82–84 per cent $NaBiO_3$ was used throughout the work.

The following substances have been oxidized on the 0·01-mol. scale and the products isolated as derivatives in good yield (70–100 per cent), the name of the oxidation product being given in parentheses: ethylene glycol (formaldehyde); diethyl tartrate (ethyl glyoxylate); *cis-* and *trans- cyclo-*

hexane-1 : 2-diol (adipic aldehyde); hydrobenzoin (benzaldehyde); lactic acid (acetaldehyde); mandelic acid (benzaldehyde). The initially rapid oxidation of lactic acid in aqueous solution soon stopped if the calculated amounts of reagent and lactic acid were used, presumably owing to the presence of unoxidizable esters. The reaction has been applied successfully on the 0·25-mol. scale for the preparation of ethyl glyoxylate and adipic aldehyde, and also of pelargonic aldehyde and azelaic aldehyde acid from 9 : 10-dihydroxystearic acid.

This type of oxidation is being further investigated, and work has been started on the oxidation of olefines by the same reagent: a full account will be published elsewhere in due course.

Note added in proof. In recent experiments the use of A.R. sodium bismuthate has been found more convenient, on account of its more uniform physical state.

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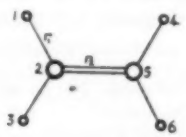
Interaction Terms in the Potential Functions for Polyatomic Molecules

IT has been suggested that interaction terms in the potential functions for polyatomic molecules are derived from the changes in bond-hybridization which accompany the nuclear displacements[1]. The following considerations may be of some interest. In ethylene itself, the constant for interaction between the deformation of the terminal $\widehat{CH_2}$ angles and the stretching of the C=C bond is not absolutely determinable, since the $\widehat{CCH}$ angles change simultaneously. Referring to the accompanying figure, suitable valence force co-ordinates for the class A_g vibrations are as follows:



$$\nu_{CH_2}, \quad \Delta_1 = \Delta r_{12} + \Delta r_{23} + \Delta r_{45} + \Delta r_{56}$$
$$\nu_{C=C}, \quad \Delta_2 = \Delta r_{25}$$
$$\delta^s\widehat{CH_2}, \quad \Delta_3 = r_1\,(\Delta\theta_{12} + \Delta\theta_{46} - \Delta\theta_{15} - \Delta\theta_{25} - \Delta\theta_{24} - \Delta\theta_{26}).$$

If the force constants going with this set of co-ordinates are written as a matrix d, then the required constant is d_{22}; but it is not possible to ascribe separate constants for the interactions $\Delta r_{25} \cdot r_1\Delta\theta_{12}$ and $\Delta r_{25} \cdot r_1\Delta\theta_{15}$. If we destroy the symmetry by replacing atom 6 by a substituent, the nine planar vibrations fall into a single symmetry class, (A'). With co-ordinates

$$\nu_{C=C}, \quad \Delta_1 = \Delta r_{25}$$
$$\delta^s\widehat{CH_2}, \quad \Delta_2 = r_1(\Delta\theta_{12} - \Delta\theta_{15} - \Delta\theta_{25})$$
$$\delta_{CH_2}, \quad \Delta_3 = r_1(\Delta\theta_{46} - \Delta\theta_{24})$$
$$\delta_{CH_2}, \quad \Delta_4 = r_1(\Delta\theta_{15} - \Delta\theta_{25});$$
$$\cdots\cdots\cdots\cdots$$

and factoring[2] out the vibrations in the order ν_1 to ν_4 (having previously factored out the three C—H stretching modes), the following values for the interaction constants in vinyl chloride are obtained, using accepted assignments[3]:

$$\left.\begin{aligned} d_{12} &= -0{\cdot}247 \\ d_{13} &= -0{\cdot}249 \\ d_{14} &= 0{\cdot}014 \end{aligned}\right\} \times 10^5 \text{ dynes/cm.}$$

The constant d_{23} in ethylene (normalized to correspond to d_{12}), by the same procedure, takes the value $-0{\cdot}232$, and the analogous constant in vinylidene chloride $-0{\cdot}255$, $\times 10^5$ dynes/cm. The practically identical values of d_{12} and d_{13} for the vinyl group can only mean that the constant for interaction between deformation of the terminal angles and C=C stretching is negligible, there being a positive constant for the interaction $\Delta r_{CC} \cdot r_{CH}\Delta\theta_{CCH}$ of magnitude $\sim 0{\cdot}25 \times 10^5$ dynes/cm. The negligible value of d_{14} will be due to the two $\widehat{CCH}$ deformations being out of phase in the CH_2 bending mode.

I wish to express my gratitude to Courtaulds, Ltd., for making the present programme of work possible.

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Lactobacillus lactis Dorner for the Assay of Vitamin B_{12}

Shorb[1,2,3], Rickes[4] and Shive[5] have published accounts regarding the use of *Lactobacillus lactis* Dorner for assay of vitamin B_{12}. The information disclosed by these authors does not, however, permit satisfactory assays to be uniformly conducted in liquid medium. Moreover, extreme inconsistency has been encountered by many workers in this field.

Investigations in these laboratories have resulted in the evolution of a technique which gives results comparing very favourably with other microbiological assays.

We have found that *Lactobacillus lactis* Dorner is remarkably prone to change its morphology under different cultural conditions, and that these changes alter its growth characteristics and its sensitivity to vitamin B_{12}. When the organism is in an insensitive condition, satisfactory assays may be performed even when bacteriological peptone is used as the basal medium.

It is difficult to ensure a uniform degree of *insensitivity*; but the organism has been maintained in a constant condition of high sensitivity from a single colony isolation through more than 150 daily sub-cultures on agar containing 1 per cent 'Evans Bacteriological Peptone', 0·1 per cent 'Evans Hepamino', 0·1 per cent 'Tween 80' and either 5 per cent tomato juice or 0·01 per cent potato extract fraction. An overnight culture of this is washed into assay medium fortified with 0·1 per cent 'Hepamino', 0·1 per cent 'Tween 80', 2 per cent glucose and a source of *T.J.* factor. After incubation at 37° C. for 4–6 hours, the culture is washed twice with assay medium deficient in *LLD* factor, *T.J.*

factor, and glucose. Three drops of an opacity 1/5 is used for assay inoculation. All organisms in the inoculum should give a solid Gram-positive stain. Exposure to normal saline for more than one to two hours has a deleterious action on the organism.

With an organism of this high sensitivity, it was found difficult to get a constant source of *T.J.* factor which did not also contain sufficient *LLD* factor to interfere with the assay. A satisfactory preparation has been obtained using material precipitated by ether from a phenol extract of the 50 per cent alcohol-soluble, 80 per cent alcohol-insoluble fraction of potato extract. This is now being used at a final concentration of 10 γgm. per ml. of final assay medium. A very low blank is obtained with this supplement.

Using aluminium-capped tubes of uniform bore, and following the usual procedure of autoclaving the final medium at 10 lb. pressure for 10 min., sometimes a perfect assay growth was obtained; but occasionally very high blanks were found. This was shown to be a function of the particular autoclaving, and was found to be associated with glucose and the acid-hydrolysed casein used as a source of nitrogen. When these two materials are autoclaved together under the above standard conditions, some growth-factor similar in effect to vitamin B_{12} *may* be formed. This tendency increases with the alkalinity of the medium, but rarely occurs at *p*H 5·5. If the glucose and casein are autoclaved separately, no growth-factor is produced. The effect of this change is only apparent when the organism is in a highly sensitive condition. Some batches of glucose may become acid on autoclaving and so reduce the *p*H to a safe figure before the undesired reaction has taken place.

Our current practice is to add aseptically the vitamin preparation to be tested, glucose and potato extract, to otherwise complete basal medium which has been autoclaved at *p*H 5·5. More than a hundred assays have been performed using this technique without encountering high blanks.

An identical shape of dose response curve is obtained with all types of liver extract, crystalline vitamin B_{12} and 'Thymidine'. The shape of the curve is not altered either by blending any of the above or submitting the liver extracts to digestion with papain.

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Senescence and Rejuvenation in *Lemna minor*

STUDIES in this laboratory on the morphogenesis of leaves have disclosed that successive leaves of *Ipomœa* differ consistently in cell size, cell number and shape[1,2]. The differences do not merely reflect changes in the external environment, but are clearly due to changes associated with the ageing of the apical meristem[3]. We now have evidence that in *Lemna minor* there is a similar ageing of the meristem. It is revealed by a progressive diminution in area of successive 'daughter' fronds from a 'mother' frond, even when the colony is grown in a constant external environment[4]. In the strain we are using, each frond produces on an average four or five 'daughter' fronds and then dies. In a typical experiment the mean area of the 'mother' frond was 5·1 mm.^{2}, and its expectation of life was 36 days. The areas, and expectations of life, of its five 'daughter' fronds were respectively 5·13 mm.^{2} and 33 days; 3·84 mm.^{2} and 30 days; 3·33 mm.^{2} and 28 days; 1·04 mm.^{2} and 18 days; and for the fifth, 1·10 mm.^{2} and 10 days. Despite this evidence of senescence, the mean area of fronds in a colony of *Lemna* does not diminish. This is because senescence is accompanied by rejuvenation. An impoverished fifth 'daughter' frond is about one-fifth the area of its 'mother' frond; but it in its turn produces 'daughter' fronds much larger than itself, and so the mean area of fronds in the colony is maintained.

The cycle of senescence and rejuvenation in vegetative reproduction and under constant environmental conditions seems to us worth recording. We suspect that it is due to variations in concentration of growth-promoting substances. A full account of the evidence will appear in due course.

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A Parasitic Flea Larva

IT is well known that the larvæ of fleas live in the nests, or resting environment, of the mammals or birds on the blood of which the adults feed. One of us (H. M.) has found flea larvæ living in the fur of the Arctic hare (*Lepus arcticus groenlandicus* Rhoads) in East Greenland. During a Danish expedition in 1932–33, to Eskimonaes, Christian X Land, forty Arctic hares were examined for parasites. Fleas were found on thirty-nine of these and flea larvæ on seven —on four in considerable numbers. It is possible that larvæ were present on others, because, after they were first noticed, every hare examined was found to carry them. The adults examined were all *Hoplopsyllus glacialis glacialis* Tasch. This is the only species which has been recorded for the Arctic hare, on which it appears to be a regular parasite throughout its range[1], and the larvæ may be presumed to belong to the same species.

It was observed that the fur was spotted and matted with dark particles, presumably dried blood passed through the gut of the adults; and that the gut of the larvæ often showed bright red through the integument.

Morphologically, the larvæ show few differences from those with habits characteristic of the order[2,3], and there are apparently no gross adaptations to suit them for an ectoparasitic life. The mouth parts are not modified for blood-sucking, the mandibles having four rather blunt teeth, and it is probable that the larvæ feed on the dried blood particles. A full description of the larva will appear elsewhere.

In the forty-four larvæ examined, all three instars were present, and among the largest were some in which the fat body was well developed, giving a creamy appearance through the integument, a characteristic of fully fed larvæ in other species. No cocoons or pupæ were observed, however.

From what is known of the life-history of the Arctic hare, it is clear that no permanent nest or resting-place is used. Out of the breeding season they rest in forms, often in the shelter of boulders, but these are not permanent; they sometimes form burrows in the snow; but these also are impermanent and would contain no detritus. In the breeding season the young are said to be active after only three days in a form, which is too short a time for even one flea life-cycle. It may be noticed, however, that the larvæ were only found in May, June and July, which is the normal breeding season of the hares[4,5,6].

The only record in the literature of larvæ living on the host that is known to us is a single case in the chigoe *Tunga penetrans* (L.), where the larvæ were found in the scrapings of human skin[7]. In this species the female burrows in the skin of the host, and lays its eggs without leaving the burrow. The larvæ are normally found in the 'nests' of the host, which is man. In *H. glacialis* the adult does not burrow, and it appears that the larval ectoparasitic habit is a normal one, and not an occasional occurrence.

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Experimental Macrocytic Anæmia in the Rat Treated with Purified Liver Extract, Pteroyl Glutamic Acid and Vitamin B_{12}

We have described elsewhere a technique for the production of experimental macrocytic anæmia in the rat by the formation of a *cul-de-sac* in the small intestine, and preliminary observations suggested that a hæmatological remission could be induced in some of the anæmic animals by treatment with purified liver extracts[1,2]. An experiment was planned to test the effects of continued treatment with large doses of purified liver extract ('Anahæmin'), pteroyl glutamic acid and vitamin B_{12} on this experimental anæmia, and the results so far are sufficiently interesting to warrant this brief report.

The blood counts of the rats in our post-operative colony were checked at weekly intervals, and anæmic animals were assigned in sequence to the four groups shown in the accompanying table. All the animals were maintained on a standard diet under similar conditions. Group I received no treatment, and served as controls. Group II were given 0·5 c.c. of 'Anahæmin' by intramuscular injection three times weekly. Group III were given 7·5 mgm. of pteroyl glutamic acid by intramuscular injection three times weekly, and Group IV received 20 μgm. of vitamin B_{12} by intramuscular injection three times weekly. A total of 26 rats was used in the four groups.

Controls	'Anahæmin'	Pteroyl glutamic acid	Vitamin B_{12}
11	20	*139	1
15	16	20	11
1	*74	*122	*43
*106	4	*72	1
23	9	*79	*72
34	2	*51	2
6	*30	—	—
—	—	—	—
Mean survival 28	22	80·5	21·2

The figures show the number of days that each animal survived after treatment had begun. The italic figures refer to rats which are still alive at the time of writing, and asterisks indicate animals which gave a hæmatological response. It is evident that pteroyl glutamic acid increased the survival time whereas neither 'Anahæmin' nor vitamin B_{12} seemed to prolong the lives of anæmic rats. In fact, these last two therapeutic substances gave a shorter mean survival than the controls, though the reduction is not statistically significant. The number of animals is small, and some of them died from complications, such as rupture of the distended segment of gut, or from causes other than anæmia.

Animals were considered to be anæmic when their hæmoglobin-levels had fallen below 10 gm. per 100 ml., and stained blood films showed the characteristic blood picture. A hæmatological remission was considered to have occurred if an animal survived four weeks or more and its hæmoglobin-level rose to or above 11 gm. per 100 ml. One spontaneous remission was observed in the control group, while there were two remissions in each of the groups treated with 'Anahæmin' and vitamin B_{12} and five in the group treated with pteroyl glutamic acid. It is apparent that a high proportion of anæmic animals responded to pteroyl glutamic acid. The effects of 'Anahæmin' and vitamin B_{12} were not so clear cut. It is our impression that the remissions observed after the exhibition of these two substances were not fortuitous; but in view of the undoubted occurrence of spontaneous remissions in untreated rats, it will be necessary to extend the present series to clear up this point.

In view of the capricious responses to liver extract and vitamin B_{12} and the apparent inability of these substances to prolong the lives of anæmic animals, our earlier suggestion that this preparation might be useful in the assay of the anti-anæmic factor has not been substantiated. Nevertheless, the preparation will be valuable in studying the role of pteroyl glutamic acid in the macrocytic anæmias and its relationship to the liver factors.

We are indebted to Dr. E. Lester Smith and Messrs. Glaxo Laboratories, Ltd., for supplies of vitamin B_{12}.

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Growth-Cycle of Influenza Virus

HOYLE has recently published[1] an account of some experiments which lead him to put forward certain revolutionary views. It is often assumed that the influenza virus, a particle of about 100 mμ diameter, gains entrance to a susceptible cell, and in the cytoplasm proceeds to multiply by binary fission. Hoyle believes that, once absorbed, the elementary body becomes broken up into particles of about 10 mμ diameter and that these particles, which have been previously recognized as the soluble antigen, are the tissue forms of the influenza virus which multiply within the cell. He presumes that later these small particles recombine to form elementary bodies which are cast out of the cell and which are specifically adapted for absorption on to the receptor sites of other susceptible cells.

The evidence adduced by Hoyle for this hypothesis is that when influenza elementary bodies are placed on the chorio-allantoic membrane of fertile eggs under suitable conditions, the development of soluble antigen can be demonstrated by complement fixation some hours before the elementary bodies can be demonstrated by red cell agglutination. The whole argument depends upon the relative sensitivity of the two methods, and specifically on the availability of elementary bodies in the membrane for absorption on to red cells afterwards. This availability may depend upon factors other than simple elution from tissue fragments, which is in any event only partial.

I have studied the same problem using a new method of complement fixation which has been fully described elsewhere[2]. In this complement-fixation test, the maximal number of units of complement fixed is a measure of the antigen concentration. If the logarithms of the units fixed are plotted against the serum dilutions to a standard scale, the area under the curve can be used as a measure of the amount of fixation. By selecting two influenza *A* strains, *PR* 8 and Barratt, and using two pools of immune ferret serum prepared against each of these strains, it has been possible to distinguish in the complement-fixation test between the strain-specific elementary body antigen and the group-specific soluble antigen. Thus the *PR* 8 ferret serum titrated with a *PR* 8 elementary body suspension, standardized against homologous mouse antiserum, gave 5·5 units maximally fixed, a serum titre of 1/630 and an area under the curve of 80 cm.². There was no fixation at all with Barratt elementary bodies in the same concentration. Similarly, the Barratt ferret serum with standardized Barratt elementary-body antigen gave 4·0 units maximally fixed, a serum titre of 1/520 and an area under the curve of 63 cm.². Again there was no fixation with *PR* 8 elementary bodies.

In contrast, the soluble antigens elaborated by these two strains were almost completely non-specific. They were prepared from chorio-allantoic membrane suspension which had been centrifuged at 31,000 *g* for two hours. With the *PR* 8 serum, the area with *PR* 8 antigen was 46 cm.² and with Barratt antigen 45 cm.²; with the Barratt serum the homologous antigen gave an area of 63 cm.² and the *PR* 8 antigen 44 cm.².

Infecting fertile eggs intra-allantoically with *PR* 8 strain, it was found that the complement-fixing antigen which appears in the allantoic fluid during the first twenty-four hours is all removed by absorption with fowl red-blood cells, that is to say, is entirely represented by elementary bodies (Table 1). But if the eggs are harvested later, at a time when the chorio-allantoic membrane has begun to disintegrate, another antigen is also present (Table 1). This antigen is not absorbed on to red cells, but is in the main sedimentable under conditions which suggest that it is somewhat larger than the elementary bodies. It cannot be aggregated soluble antigen, since serologically it behaves as a mixture of specific and non-specific elements. For example, a *PR* 8 antigen of this type gave with the homologous antiserum a fixation of 95 cm.² and with the heterologous antiserum an area of 25 cm.². The small amount of residual antigen left in the supernatant after high-speed centrifugation and reabsorption with red cells may be soluble antigen. But it is difficult to get an absolutely clean separation of supernatant and deposit.

Table 1. Complement fixation of various *PR* 8 allantoic fluids with *PR* 8 immune ferret serum

Allantoic fluid harvested after	Treatment	Hæmagglution titre	Maximal units of complement fixed	Amount of fixation area (cm.²)
24 hr.	i	4000	15	115
	ii	16	—	24
	iii	5120	—	7
	iv	<4	—	0
48 hr.	i	4000	24	115
	ii	16	—	88
	iii	5120	—	27
	iv	<4	—	8
96 hr.	i	4000	39	165
	ii	16	—	114
	iii	5120	—	74
	iv	<4	—	24

i. Unabsorbed.
ii. Absorbed twice with R.B.C.
iii. Unabsorbed, supernatant after 31,000 *g* for 2 hours.
iv. As for iii but supernatant then absorbed with R.B.C.

Chorio-allantoic membranes were infected with a large number of *PR* 8 elementary bodies, and batches of membranes were harvested at intervals, washed and ground in a mortar to a 10 per cent concentration.

Elementary bodies were first demonstrable in the allantoic fluid by red-cell agglutination between the fourth and sixth hours after infection. With the complement-fixation technique and using as a baseline the fixation of membrane suspensions harvested immediately after infection, no rise of antigen could be demonstrated at the second hour, but a rise occurred between the second and fourth hours. From Table 2 it is clear that at this time the antigen is a mixture of specific and non-specific elements.

Table 2. Development of *PR* 8 complement-fixing antigens in the chorio-allantoic membrane

4-hr. membranes		Maximal units of complement fixed	Serum titre	Area of fixation (cm.²)
PR 8	*PR* 8 serum	13	256	92
	Barratt serum	13	40	55

These are antigens in the making, and it would be hazardous to offer any simple explanation. These facts do not disprove Hoyle's hypothesis; but I suggest they show that it is beyond what has at present been demonstrated. My own working hypothesis is more pedestrian. I imagine that the elementary body is formed in the membrane *pari passu* with the soluble antigen, which is of the nature of a matrix substance. The first elementary bodies which burst into the allantoic cavity are naked and

specific; later, when the membrane begins to break down, the elementary bodies are enmeshed with very small tissue particles. Particles of the chorio-allantoic membrane can be shown to fix a certain amount of complement with ferret sera, so that not only would these late elementary bodies be more easily sedimentable, but also they would be prevented from absorption on to red-blood cells and would have an apparently broader serological range. It is probable that this non-specificity is enhanced because the tissue particles contain soluble antigen.

With the strains used in this work it is not necessary to assume that the soluble antigen in a highly dispersed form ever gets into the allantoic cavity in sufficient amount to be demonstrable.

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Recrystallization of Relaxed Animal Fibres

IT is well known that wool fibres and human hair can be stretched 30 per cent in water at low temperatures (22° C.) without significant alteration of their elastic properties, provided that extension is carried out rapidly and release is immediate[1]. The released fibre returns exactly to its original length, and if it is allowed to stand in cold water for twenty-four hours before being re-stretched, the second load-extension curve is almost identical with the first: the reduction in work for 30 per cent extension is only about 3 per cent in the case of human hair. If, however, the fibre is stretched rapidly and then held at 30 per cent extension for twenty-four hours at 22° C. before release, the reduction in work, again after twenty-four hours rest in water, is 45·5 per cent[2].

The relaxation, which is the cause of weakening, is due to slow unfolding of the grids of α-keratin in the crystalline regions, accompanied by re-folding of the grids in the amorphous regions[3], which are the first to be stretched during rapid extension[4]. Rearrangement of the disorganised structure is accompanied by re-strengthening, but proceeds extremely slowly in water at low temperatures. It can, however, be accelerated by raising the temperature, as is shown by the accompanying data for human hair. After being held at 30 per cent extension for twenty-four hours in water at 22° C., the fibres were released and allowed to rest in water at the same temperature for twenty-four hours before the load-extension curve was re-determined. The fibres were then released and allowed to stand in water at the desired temperature for twenty-four hours before determining the load-extension curve again. Values for the percentage recovery of the fibres were obtained from the several sets of curves.

Temperature of treatment (° C.)	Percentage recovery
0	−6·7
22	8·4
30	20·7
38	33·1
46	43·5
54	54·8
62	63·8
70	65·0
90	49·4
100	18·8

Maximum recovery is obtained at 70° C. The very much lower value at 100° C. is, of course, due to the fact that disulphide bond breakdown[5] and setting reactions[6] intervene to impair recovery at temperatures above about 55° C. As both reactions are prevented by acids[6], higher temperatures of treatment should be permissible and more rapid re-strengthening realized in the mildly acid media which are now being used.

In order to discover the mechanism of re-strengthening, a relaxed fibre was allowed to stand in 98 per cent formic acid for one hour at 22° C., followed by twenty-three hours in water at the same temperature, before determining the third load-extension curve. When corrected for the slight weakening caused by the formic acid treatment, the percentage recovery (6·4 per cent) was similar to that of the fibre treated with water alone for the same time (8·4 per cent). But formic acid causes intense swelling by separating the grids of covalently linked peptide chains and must, therefore, have promoted molecular rearrangement within each grid. It seems probable, therefore, that re-strengthening is due to rearrangement of the grids with respect to one another—probably minor rearrangement to permit hydrogen bonding between the peptide groups of neighbouring chains.

The preceding observations explain why the craftsmen of a more leisurely age used to insist on allowing wool textile materials periods of rest between processes at all stages of manufacture. They also indicate how the beneficial effects of such ageing processes may, in future, be obtained in much shorter times.

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Piezo-electric Resonator of Ethylene Diamine Tartrate with Zero Temperature Coefficient of Frequency

IF thin square plates of ethylene diamine tartrate have two sides parallel to the Y-axis, the axis of two-fold symmetry, so that the normal to the plate is in the XZ-plane, then there are two values of the angle θ between the normal and the X-axis which lead to zero temperature coefficient of the frequency of the contour shear mode. (The angle θ is measured from the positive direction of the X-axis towards the negative direction of the Z-axis.)

The frequency equation as function of the angle θ is

$$N = \nu l = \frac{\alpha\sqrt{2}}{2}\sqrt{\frac{1}{\rho(s_{44}\cos^2\theta + s_{66}\sin^2\theta + 2s_{46}\sin\theta\cos\theta)}}$$

where ν is the frequency, l is the length of side of the square, ρ is the density and α is a constant equal to about 0·89, which can now be calculated approximately[1].

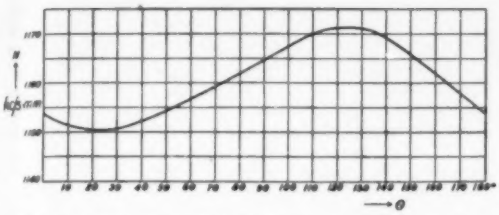

Fig. 1. Frequency constant N for square ethylene diamine tartrate plates vibrating in contour shear mode as function of the angle θ

Fig. 1 shows the frequency constant N as a function of the angle θ. The elastic coefficients s_{44} and s_{66} have positive temperature coefficients. Although the elastic coefficient s_{46} is small, its temperature coefficient has an unusually high negative value. There are two values for θ in the same quadrant for which the temperature coefficient of the term s_{46} balances that of the terms in s_{44} and s_{66}. Similarly, if the temperature coefficient of s_{46} had a high positive value, since the sign of the s_{46}-term changes in different quadrants, two values of θ for zero temperature coefficient could occur in another quadrant.

The temperature coefficient of frequency as a function of the angle θ is shown in Fig. 2. At the angles $\theta = 17°$ and $77°$, the temperature coefficient of frequency is zero. Of these two, the angle $\theta = 77°$ is specially suitable for elements for crystal filters. The properties of these plates are: $N = 1{,}161$ kc./s. mm.; coefficient of inductance $L_0 = L/d = 18{\cdot}1$ H.mm.$^{-1}$, where d is the thickness of the plate. Change of frequency with temperature T follows the parabolic law $\frac{\nu_{max} - \nu}{\nu_{max}} = a(T - T_0)^2$. The vertex of the parabola varies with the angle θ. For the angle 77°, the vertex of the parabola lies at about $T_0 = 30°$ C. The coefficient a of the parabola is 7×10^{-7}. The plates are free from other modes in a wide frequency range.

These plates of ethylene diamine tartrate resemble in many respects quartz plates rotated about the X-axis (CT, DT cuts). The frequency equation for these quartz plates is given by a similar formula; but the zero temperature coefficient of frequency is produced by opposite signs of the temperature coefficient of the main shear coefficients, and therefore the two angles for the zero temperature coefficient of frequency occur in different quadrants. Furthermore, the elastic coefficient $s_{46}' = s_{46} \cos 2\theta + \frac{1}{2}(s_{66} - s_{44}) \sin 2\theta$ is zero for ethylene diamine tartrate at about $\theta = 43°$ and 133°. Plates orientated at these angles correspond to quartz AC and BC cuts.

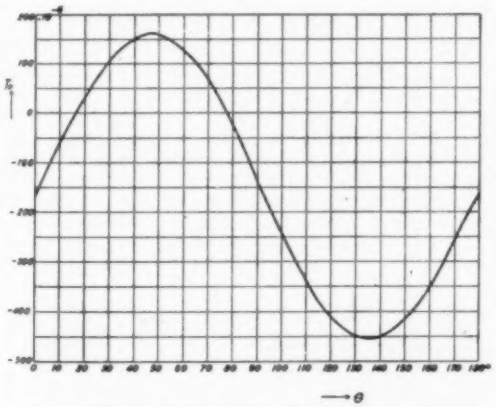

Fig. 2. Temperature coefficient of frequency for square ethylene diamine tartrate plates as function of the angle θ

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Theory of Viscosity

Let us treat flow as a rate process[1], that is, assume when two layers of molecules in a liquid slide past each other, then the molecules of the layers travel in the same layer from one equilibrium position to another. During this passage, each molecule has to break the 'bonds' between it and its nearest (and perhaps certain of its remoter) neighbours, so that the process can be represented as a unimolecular reaction. If the specific reaction-rate constant of this reaction is k', then by applying the theory of the transition state, the coefficient of viscosity η' should be

$$\eta' = \frac{\lambda_1}{\lambda_2 \lambda_3 \lambda^2} \cdot \frac{kT}{k'}, \qquad (1)$$

where λ_1, λ_2, λ_3 are the intermolecular distances in the three-space co-ordinates, λ the distance between the two equilibrium positions, k is the Boltzmann constant and T the absolute temperature.

If the theory of the transition state is to be applied to unimolecular chemical reactions, then (*a*) the molecule must be large; in the present case this means that the molecule which is about to move should form a dense packing with its neighbours, excepting naturally that hole through which the flow occurs. The result is that, as the critical temperature is approached, equation (1) will remain valid longer at high pressures than at low ones. The other condition is (*b*) that the molecules in the initial state should be always in equilibrium with those in the activated state. This condition cannot be fulfilled in the unimolecular case, and, according to Hirschfelder[2], the ratio between the real concentration C_A and the equilibrium concentration $(C_A)_{Eq}$ of the activated complex is given by $C_A/(C_A)_{Eq} = 0{\cdot}3$ to $0{\cdot}5$. If the degree of freedom corresponding to dissociation is governed by classical mechanics, the value may be even smaller. In other words, the specific rate constant determined by the real concentration is $k = 0{\cdot}3\ k'$ to $0{\cdot}5\ k'$. From this and Eq. (1) the real coefficient of viscosity appears as

$$\eta = 2\eta' \text{ to } 4\eta'.$$

If we assume that the one degree of freedom along the co-ordinate of decomposition is vibrational or

translational (which on classical theory amounts to the same thing, so that

$$f_v = \frac{kT}{h\nu} = \frac{(2\pi\mu kT)^{1/2}}{h} \cdot 2\bar{A} = f_{tr} = \frac{(2\pi mkT)^{1/2}}{h} l,$$

if the accessible space is identified with twice the average amplitude $\bar{A}$, an approximation allowed for liquids[3]), then the coefficient of viscosity is, using Eyring's expression for the free volume[4] and inserting the numerical values of the constants,

$$\eta' = 1{\cdot}09 \times 10^{-3} \frac{M^{1/2}T^{1/2}}{V^{2/3}\Delta E_v} \exp(E/RT), \quad (2)$$

where E is the activation energy per mole for viscous flow.

Trying to fit the Andrade equation (see below) let us take M, the molecular weight of the substance, to be 121; ΔE_v, the molar heat of vaporization, as 5,000 cal.; V, the molar volume, as 125 c.c.; then at ordinary temperatures

$$\eta' = 0{\cdot}4 \times 10^{-3} \exp(E/RT). \quad (3)$$

Comparing this with the equation of Andrade[5], which is for many substances

$$\eta = 0{\cdot}4 \times 10^{-3} \exp(b/vT)\, v^{1/3}, \quad (4)$$

we see at once that the coefficient of viscosity given by Eq. (4) is five times greater than that of Eq. (3) with the molar volume 125 c.c. [6]. If we take the correction of Hirschfelder into consideration, we obtain from Eq. (3) a coefficient of viscosity two to four times greater, which is a good agreement in view of the approximations.

Since the diffusion coefficient is, according to Eyring[1],

$$D' = \lambda^2 k',$$

we have to introduce the same correction, which gives

$$D/D' = 0{\cdot}3 \text{ to } 0{\cdot}5.$$

If D_{obs} is the observed value, then $D_{obs}/D' = 0{\cdot}3$ to $0{\cdot}5$, that is, $D_{obs} = D$.

It seems worth while to use the correction in other rate processes which can be described as unimolecular and to calculate its exact numerical value in every process. On the other hand, the calculation of the correction from the experimental values may throw light on the molecular interactions in liquids.

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Luminous Night Clouds

Luminous night clouds were observed in the northern sky in Scotland on the nights of July 9–10 and July 10–11, the extensive display showing characteristic wave structure in the early morning of July 11 being quite magnificent. Brilliantly blue-white in colour, the night clouds appeared about half an hour after sunset in a sky almost clear of normal cloud, were most brilliant during the hour after midnight and faded in the growing light before sunrise. A series of simultaneous photographs (one pair is reproduced here) by Störmer–Krogness auroral cameras from Abernethy and Blairgowrie will yield measurements of height, direction and speed of movement, as also of distance between successive wave-crests.

Simultaneous photographs of luminous night clouds at 00h.19m. G.M.T. on July 11, 1949, from Abernethy (above) and Blairgowrie (below) (J. F. McKellican), 27·6 km. apart. Note the displacement of corresponding cloud features with respect to the star Capella, centre Blairgowrie picture, to the right on Abernethy picture

These rare clouds, which are observed only in summer and in middle latitudes, were first studied by Jesse[1], and later by Störmer[2] using his auroral network. Occurring at heights of about 80 km., they provide valuable information concerning air movement at that level. On the evidence of their colour, it is generally believed that they consist of fine dust of cosmic or volcanic origin. It is significant that the present manifestation followed a few days after an eruption in the region of the Canary Islands.

J. Paton

Department of Natural Philosophy,
University, Edinburgh.
July 18.

[1] Jesse, *Ast. Nachr.*, 140 (1896).
[2] Störmer, *Ast. Norv.*, **1**, No. 3 (1935); *Nature*, **134**, 219 (1934); **135**, 103 (1935).

ABRASION TESTS ON DIAMONDS

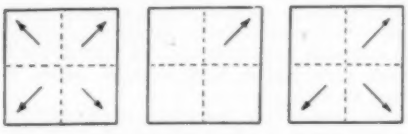
Directional Properties

VARIATIONS in the hardness or wear resistance of diamond surfaces are well known[1], and attempts have been made to explain them from the crystal structure[2]. Diamond is normally assumed to have the highest symmetry in the cubic system. There is, however, some evidence from the working of diamond that it does not possess this full symmetry[3].

In order to investigate the hardness directional properties, micro-indentation or micro-abrasion tests may be used. Although the National Bureau of Standards, Washington, has succeeded in making a number of indentations with the Knoop indenter (elongated pyramid) into the cube plane of an octahedral diamond[4], no variation with direction was revealed. We have tried to obtain indentation with a double-cone diamond indenter pressed against a diamond face; but no indentations were observed. Only elastic flattening of the diamond indenter itself was detected.

Interesting results have now been obtained with a new micro-abrasion tester, which consists of a 1-in. diameter (110° included angle) cast-iron wheel of double conical shape provided with fine diamond powder 0–2 micron size and rotating at about 10,000 r.p.m. Against this the diamond surface to be tested is lightly pressed. Well-pronounced abrasion marks were obtained in a number of directions on the diamond, these being known as 'preferred' directions. In the 'non-preferred' directions no abrasion marks were obtained on good diamond crystals; but marks did appear in the single instance of a very low-grade stone of crushing boart quality. Without exception the abrasion marks in the preferred direction had a well-polished surface permitting investigation of their forms by interferometric methods.

Fig. 1 shows the preferred directions in the cube plane of an octahedral diamond. According to crystallographic views, there should be four preferred directions parallel to the two diagonals which coincide with the directions of two crystal axes; but the usual view of the diamond polisher is that there is only one preferred direction parallel to one diagonal. The results of our own investigations on two different diamonds, one an alluvial and one a so-called 'glassy' octahedron with almost plane faces, suggests that there are only three good grinding directions, and a fourth very poor one. In the dodecahedral plane the conditions are somewhat simplified as there can be theoretically only two preferred directions parallel to one crystal axis, whereas the diamond polishers actually maintain that there is only one preferred direction in this plane. We find that the alluvial stone accepted an abrasion mark in two directions, whereas the glassy stone could be abraded only in a single preferred direction.

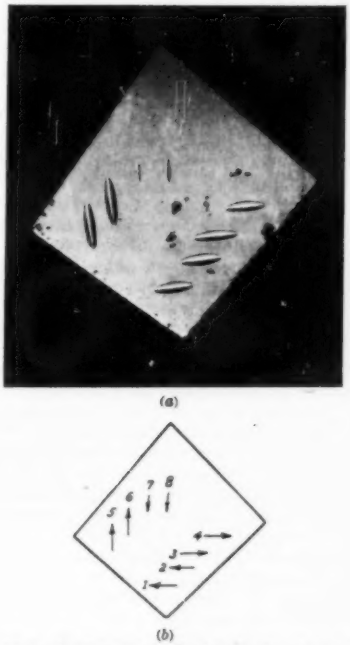


(a) (b) (c)

Fig. 1. Schematic representation of the cube plane of diamond; arrows indicate preferred direction, dots indicate 'non-preferred' direction. (a) Theoretical assumption; (b) assumption of diamond polishers; (c) condition revealed by tests (see Figs. 3a, b). Arrows parallel to crystal axes

(a) (b)

Fig. 2. Schematic representation of dodecahedron plane of diamond, designations as for Fig. 1. (a) Theoretical assumption; (b) assumption of diamond polisher. The existence of both assumptions has been confirmed by test. Arrows parallel to crystal axis

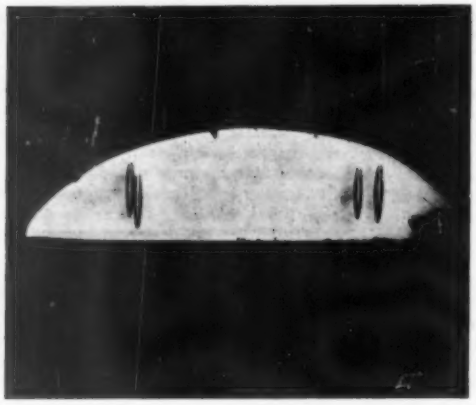


(a) (b)

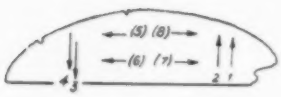
Fig. 3. (a) Photomicrograph of polished cube plane of glassy stone with abrasion marks 1–8; (b) order and direction of abrasions

Abrasion tests were made with the glassy stone on octahedral planes, both natural and cleft; but on these no abrasion mark could be detected under the microscope even at 750 × magnification. The stones have also been under examination by multiple-beam interferometry (Prof. S. Tolansky); but no traces of abrasion marks could be found.

For the evaluation of the abrading, the volumes of the abraded material should be determined. Fig. 3b shows the abrasion marks in the cube plane of the glassy stone, all eight tests being carried out in possible good running directions, and using the same number of revolutions, to within a few per cent. The numbers indicate the sequence of the test runs. Marks 3 and 4 are a good repetition of the marks 1 and 2, but are made from the opposite direction;



(a)



(b)

Fig. 4. (a) Photomicrograph of polished dodecahedron face of alluvial diamond with abrasion marks, some of them invisible; (b) order and direction of abrasion marks 1–8. Marks 5–8 not visible in photomicrograph

marks 7 and 8, which are very faint, are opposite to the good direction 5 and 6. Since the faint mark 7 immediately follows the good mark 6, the abrading quality of the wheel cannot have suffered appreciably. Fig. 4*b* shows the abrasion marks on the dodecahedral plane of the alluvial stone. Here all cuts 1–8 in four directions (two good ones and two bad ones) were repeated. Marks 3 and 4 are almost as good as marks 1 and 2, indicating no deterioration of the grinding wheel. Cuts 5–8 in the non-preferred direction did not leave any visible trace.

No general conclusions as to the relative abrasion-rate in the different planes can yet be drawn with certainty, particularly as the condition of the grinding wheel may have been varied slightly in the course of the tests.

In comparison with abrasion methods in which only a surface layer parallel to the original surface of the substance to be tested is removed, the method described here permits the carrying out of many abrasion tests in the same surface layer without always removing the evidence of the previous tests.

This new testing method (originated by one of us, namely, P. G.) allows very small specimens of hard materials to be tested, and it removes only very small amounts of material from the surface, which is in marked contrast to abrasion tests made on flat disks or cylindrical drums.

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W. Stern

Industrial Diamond Information Bureau,
Industrial Distributors (Sales), Ltd.,
London, E.C.1.

[1] Tolkowsky, M., doctoral thesis, University of London (1920). Drane, H. D. H., *Research*, **1**, 191 (1948). Grodzinski, P., *Indust. Diamond Rev.*, **3**, 7 and 13 (1943).

[2] Nat. Phys. Lab. Collected Researches, London, **24**, 1, etc. (1931); *Amer. Mineral.*, **24**, 661 (1939).

[3] Eppler, W. F., and Rose, M., *Zentralbl. Mineral.*, **A**, 251 (1925). Raman, C. V., and Ramaseshan, S., Second Symp. on Structure and Properties of Diamond (Bangalore, 1946).

[4] *Indust. Diamond Rev.*, **5**, 103 (1945).

Interferometric Examination

We have applied multiple-beam interference methods to the study of abrasion test marks cut in diamond surfaces prepared for us by a new method due to P. Grodzinski (see above note). In this abrasion test the directional mechanical properties of the diamond are revealed by the sizes of the cuts produced in the various directions by (as near as possible) the same number of revolutions, under constant load, of a sharp grinding wheel charged with diamond dust. The accompanying illustrations are interferometric studies made on the cube top face of a truncated pyramid of a 'glassy' diamond, the same face, in fact, as that described in the preceding note by Grodzinski and Stern.

(c)

Fig. 5

Fig. 5*a* shows multiple-beam interference fringes using green mercury light with the various abrasion cuts described as Fig. 3*a* by Grodzinski and Stern (× 20). It has been necessary to over-expose strongly the fringes on the flatter regions in order to secure sufficient intensity within the cuts, hence the apparent excessive fringe broadening in these regions is not genuine, merely photographic. Fig. 5*b* shows four of the cuts at a higher magnification, taken from a different photograph.

Owing to the very sharpness of the fringes, it is not possible with Fizeau fringes to secure a profile of a depression which is of the order of only half a light-wave deep, unless a number of different wave-lengths are employed. For such a depression the white light fringes of equal chromatic order are peculiarly admirably suited, and in Fig. 5*c* are shown such fringes for the shallowest cut of Fig. 5*a*. Such fringes reveal precisely the true profile, and the section selected here is the minor axis of the elliptical abrasion mark. The depth is a little less than half an order.

Four principal features may readily be recognized from these sensitive interference fringes, namely:

(1) The polish of the diamond surface within the abrasion cut is so good that high-definition fringes appear within each depression. The abrading wheel therefore polishes while removing material, and this is true for all the directions illustrated.

(2) From the fringe patterns the precise profile and the actual volume of removed material can be derived. The particular cuts illustrated vary in depth from a half to four light-waves, and all show a high degree of symmetry.

(3) All the figures, in particular Fig. 5c, show that the abrading wheel forms a clean-edged cut with no tendency at all to produce ploughing up at the boundary or distortion beyond the obvious geometrical boundary. The slight rounding at one edge in Fig. 5c may very easily arise either from a minor wobble on the cutting wheel or slight eccentricity.

(4) A most surprising feature is the shallow flatness of all the cuts. The approximate included angle across the minor axis derived by measurement, or, for example, roughly obvious from Fig. 5c when scale differences are remembered, is close to 176°. Yet the included angle of the double conical grinding wheel as measured both before and after grinding is 110°. This striking discrepancy seems to indicate considerable elastic flattening of the conical metal cutting wheel at the cutting edge (with consequent recovery). It is possible that wobble of the cutter contributes to this by broadening the abrasion mark, yet an elastic flattening over only a quite small depth suffices. That the flattening is most violently severe is, of course, clear from the very existence of the fringes, for an included angle of 110° would be an impossibly large angle for showing wedge fringes, particularly with multiple beams. It would be of interest to perform the experiment with a diamond wheel if that were possible; but then the inevitable small radius of curvature would prove prohibitive.

It is thus clear that any direct geometrical method for estimating the volume of the cut based upon the geometry of the recovered wheel will be completely false and liable to very great error. Such a volume estimate can only be made, if required, with the help of interferometry. For routine test purposes, it will be necessary to restrict measurement to the length and breadth of the abrasion unless interferometric procedures are available.

The observations are being extended to include other crystallographic directions in diamonds.

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April 2.

THE NEW SOUTH WALES UNIVERSITY OF TECHNOLOGY

By A. DENNING
Acting Director of the University

An act to incorporate the New South Wales University of Technology was approved by the New South Wales Parliament in its third session which terminated during April. The University has been established as a body corporate with perpetual succession and statutory authority to assume responsibilities similar to those undertaken by other Australian universities.

The Act defines the objects of the new University to be: (*a*) the provision of facilities for higher specialized instruction and advanced training in the various branches of technology and science in their application to industry and commerce; and (*b*) the aiding by research and other suitable means of the advancement, development and practical application of science to industry and commerce.

Action is being taken in accordance with the legislation adopted by Parliament to constitute a governing Council to exercise full control over the activities of the new University. The Council will consist of thirty members and be representative of Parliament, industry and commerce, the trade unions, technical education, professional bodies, the University of Sydney, and the teaching staff of the new University, its undergraduates and graduates. Increased representation of the graduate body is to be provided as soon as a sufficient number of graduates have completed University of Technology courses.

The governing Council, under the authority given to it by the Act, (*a*) may provide courses in applied science, engineering, technology, commerce, industrial organisation and such other related courses as it deems fit, and may, after examination, confer the several degrees of Bachelor, Master and Doctor, and such other degrees and such certificates in the nature of degrees or otherwise as it thinks fit; (*b*) may from time to time appoint deans, professors, lecturers and other officers and employees of the University; (*c*) shall have the entire control and management of the affairs, concerns and property of the University; and (*d*) may act in all matters concerning the University in such manner as appears to it best calculated to promote the objects and interests of the University.

The Council has also been given power to establish and maintain branches, departments or colleges of the University of Technology at Newcastle, Wollongong, Broken Hill, or such other places in the State of New South Wales as the Council deems fit.

Provision is made for the acceptance by the Council of gifts and bequests made to the University. Any land acquired for University purposes is to be vested in the University of Technology. Special investigations may be carried out in any technological or scientific matter at the request of any authority, firm or person, and subject to fees charged by the Council.

A building comprising 21,000 sq. ft. of floor space is being altered structurally to serve as the first research centre of the University of Technology, and a considerable amount of machinery and equipment is on order. Industrialists will be invited to bring their problems to the University of Technology, and it is hoped that a number of research projects will be commenced this year.

The University has already made considerable progress under the guidance of a Developmental Council appointed in August 1947 by the Minister for Education, the Hon. R. J. Heffron. The need for such early development was stressed by the urgent demands for skilled technologists and applied scientists by expanding post-war industry. A decision was accordingly made by the Developmental Council to avail itself of existing technical education facilities until such time as the University of Technology could make use of its own buildings, staff and equipment.

The erection of the first University building is now being undertaken on a large area of land at Kensington reserved for university purposes. Applications have also been invited both in Australia and overseas in connexion with the appointment of professors to occupy eight foundation chairs at the University of

Technology. It has been specified that these officers should not only be distinguished academically, but should also have a good background of industrial research.

On March 1, 1948, professional degree courses of four years duration were established in civil, electrical, mechanical and mining engineering. These undergraduate courses are of a type unique in Australia. They are spread over four years and have been organised on a system requiring full-time day attendance at the University of Technology for approximately half the year (March to September), and practical experience of a planned nature in industry for the remainder of the year. A number of industrial and Government departments are interested in this form of training as it provides a means of training their cadets both academically and in the practical aspects of engineering. For this reason they have nominated students to attend these courses, paying their fees and the ordinary cadet rate during their periods in industry. Students' attendance at the courses is also counted as part of their service for seniority grading and salary purposes. In addition, a number of scholarships have been granted with liberal living allowances, particularly from the coal-mining industry, which is anxious to secure skilled personnel.

Additional degree courses in chemistry and chemical engineering were instituted on March 7, 1949. On the same day the first postgraduate course—that of electronic engineering—was commenced. One of the major functions of the new institution will be to provide a wide range of such postgraduate courses. Further degree courses in technology will be established in March 1950.

Students admitted to degree courses at the N.S.W. University of Technology are required to have entrance qualifications at least equal to the standard of the usual university matriculation, and, in addition, mathematics is necessary.

Courses already in operation compare favourably both in subject content and in lecture and laboratory time with courses at leading world universities and technological institutions of the higher range overseas. Every course established to date has been carefully reviewed and approved by advisory committees consisting of competent men in each technological field, comprising the executives of major industries, their chief engineers, and senior educationists from recognized higher educational institutions.

Special features have been introduced in the planning of courses. The first is the extensive practical experience in industry which supplements lecture and laboratory work at the University. For example, engineering students in the new courses gain approximately five months experience in industry each year, this practical work being carefully organised and supervised in every detail. Secondly, there will be in all faculties compulsory courses in language, literature, history, economics and psychology. Such courses will avoid the handicaps which arise from narrow specialization. Graduates will thus be not merely technical experts, but technical experts with a broad understanding of human affairs. The University will offer also the usual social and athletic activities of university life.

A further feature of the organisation of the new University will be the facility available to students already in employment and enrolled in appropriate courses at the technical colleges to transfer at certain stages to degree courses at the University of Technology. Conversion courses are also being arranged to permit those in possession of technical qualifications from technical colleges and other universities to resume their studies in order to secure the degree or higher degrees of the new University. The first of these courses will commence in 1950. Such facilities, in conjunction with a system of scholarships, living allowances and reasonable fees, will extend the highest form of tertiary education to the large group of capable technical students in New South Wales for whom there are no suitable courses of study at existing universities, or who are debarred from attendance at present courses by reason of economic circumstances.

The incorporation of the New South Wales University of Technology by the State legislature is an event of great importance in the educational development of Australia. The aims and functions of this new institution are similar to those of the world-famed technological institutions in the United States and of the technical universities of continental Europe which have done so much towards the industrial development of their respective countries.

The governing Council of the new University, in the exercise of its functions, will co-operate to the full with the University of Sydney and other universities, the Commonwealth Scientific and Industrial Research Organisation, the Department of Technical Education and other Commonwealth and State institutions devoted to science and research. It is confidently expected that the University of Technology will be accorded similar co-operation by those who are interested in the educational and industrial advancement of Australia.

ACADEMIA SINICA (1928-48)

UNDER the title "Academia Sinica (1928–1948)" there has been published a very readable account of the foundation and work of Academia Sinica, which has its headquarters at Nanking, and of the thirteen associated research institutes. Appendixes give the constitution of the Council and list the administrative and research staff.

Although organised so long ago as March 1941, the Institute of Mathematics was formally established only in July 1947. Its present staff consists of three research fellows and one research associate with junior assistants, and current work covers the theory of series and of numbers, differential geometry, topology, abstract algebra and mathematical statistics. Pending the completion of a new building, the Institute is sharing the rooms of the Institute of Physics at Nanking. The latter Institute was established in March 1928; but moved into its present quarters in 1948. Its seven research fellows, two part-time research fellows and four research associates have been concerned with determinations of the radium content of minerals and of the purity of radium nitrate by physical methods, the radioactivity of minerals and the restoration of ancient bronze pieces; and when equipment is ready, work on the preparation of large single crystals of desired orientation, the mechanical behaviour of very fine single-crystal wires, the behaviour of the lattice of polycrystalline wires, the effect of stress upon residual magnetism and coercive force, and the relation between magnetostriction coefficient and the stress effect of coercive force is projected.

The Institute of Astronomy, founded with Academia Sinica in 1928, is the successor of the Peking Central Observatory, and now controls the Purple Mountain Observatory and the Phœnix Hill Observatory at Nanking and Kunming, respectively. A photometric and spectrophotometric study of the sun, planets and stars with the 24-in. reflector, observations of Cepheids and variable stars with the Ross camera and the astrocamera, and studies on solar activities with the spectroheliroscope are planned. The Institute of Chemistry, also founded in 1928, now occupies part of the former Shanghai Science Institute. Its work has included the ultra-violet absorption spectra of simple polyatomic molecules, the synthesis of compounds related to the sex hormones and the chemistry of fused ring systems, the chemistry of the santonins, and the extraction of alkaloids from native plants and study of their structure. Some of this work has had to be suspended, and that now in progress includes studies of the kinetics of the reactions of alcohols, aldehydes and ketones with hypoiodite solutions; phosphatases and the mechanism of their action; the application of the Hofmann reaction; the preparation of local anæsthetics; the effect of ions on the determination of sulphate; the determination of tungsten; the electro-deposition of metals and the determination of uranium in ores rich in columbium and tantalum.

The Institute of Geology, now re-established in Nanking, with eleven research fellows, four research associates and seven corresponding fellows, has explored the mining areas of Hupeh, the structure and tectonic history of the Tsinling range and the Nanking hills, coal-fields and mines in Kwangsi; the stratigraphical development, structure and mineral resources of the Nanking region and the mountain ranges between Szechuan and Kupeh and between Kweichow and Hunan. Quaternary glaciation has been discovered in the Lu-Shan and other areas, and most of the plant fossils collected from Kiangsu and elsewhere have been described; while in geomechanics the Institute has developed a new branch of geology.

The Institute of Zoology was formed in 1944, with the Institute of Botany, out of the Institute of Zoology and Botany organised in July 1934 to succeed the Metropolitan Museum of Natural History established in January 1930. Following these successive re-organisations, the Institute has turned its attention to fish biology, entomology, parasitology, protozoology and experimental zoology, but has not yet resumed work in oceanography. The research staff of the Institute of Botany comprises six research fellows and two research associates, and work in progress includes a survey of higher plants in eastern China, a continuation of the study of higher fungi of China, studies of freshwater Algæ in south-western China, plant physiology, forestry, plant morphology and pathology, and cytogenetical studies on wheat, millet and sorghum.

The Institute of Meteorology, which returned to its original site in September 1946, is now engaged entirely in research on climatology, dynamical meteorology and long-range forecasting. A map of magnetic anomalies in south China is in preparation, and some phases of the theory of seismic waves are being studied. The Institute of History and Philology, established at Canton in 1928 and rehabilitated, after successive evacuations, at Nanking in 1946, is organised in four sections, two of which deal with archæology and with anthropology and ethnology, respectively. Much of the research work of these sections has already been published.

The Institute of Social Sciences, founded at Shanghai in March 1928, and moved to Nanking in January 1932, incorporated the Institute of Social Research, Peiping, in July 1934, and is now located at Li-Chuang, Szechuan. The staff of six research fellows, two part-time research fellows and four research associates is now engaged chiefly in the study of Chinese economy and finance arising out of war conditions, including a study of the national income of China. The Institute of Medicine, established in March 1944, is at present located at Shanghai, where a physiological unit, an organic chemistry unit (studying citrinin) and biochemical unit are at work, but is still being organised.

The Institute of Engineering was organised in March 1928, and its programme has included research on porcelain, on glass (taken over from the Institute of Chemistry), the metallurgy of iron and steel, timber in Yunnan, the design of internal combustion engines, extraction of cobalt oxide from crude ores, electroplating and plastics. The Institute is still located partly in Kunming and partly in Shanghai. The Institute of Psychology has now returned to Shanghai, where it was originally founded in May 1929, and a new programme of neurophysiological research is being planned in place of the studies in physiological and industrial psychology and comparative neuroanatomy interrupted by the war in China.

ENDOCRINE GLANDS IN INSECTS

DURING the past fifteen years it has been proved that the processes of growth and reproduction in insects are controlled by hormones circulating in the blood. In some instances the source of these hormones has been well established. For example, the 'juvenile hormone' present in the young stages, which prevents the premature occurrence of metamorphosis, is a product of the corpus allatum. But there is still much confusion, both in knowledge and in terminology, about the organs which may be concerned in these hormonal mechanisms.

A memoir published recently by P. Cazal* should go far to clarify the subject, at least on the morphological side. This paper, which is abundantly illustrated with simplified anatomical drawings and exact histological figures, deals in great detail with the 'retrocerebral endocrine glands' and the associated sympathetic or stomatogastric system in all the orders of insects. A total of some 130 species of insects has been studied. There is fairly general agreement about the structures comprised within this system; they are the frontal ganglion, the recurrent nerve, the hypocerebral ganglion, the corpora cardiaca (for which Cazal proposes the name 'corpora paracardiaca') innervated from a medial and lateral group of ganglion cells in the pars intercerebralis of the brain, the corpora allata and the associated nerves.

The author subscribes to the analogy, developed by Hanström and others, between the retrocerebral system in insects and the hypophysis of vertebrates. In both we have an ectodermal epithelial rudiment (the adenohypophysis on one hand, the corpus allatum on the other), homologous perhaps with a

* "Les glandes endocrines rétro-cérébrales des insectes (étude morphologique)." By P. Cazal. Pp. 227. (Paris: *Bull. Biol. Fr. Belg.*, Suppl. 32, 1948.)

cephalic nephridium, which unites during growth with a nervous rudiment (the neurohypophysis or the corpus cardiacum) to form an endocrine complex. Both neurohypophysis and corpus cardiacum are innervated from cells in the brain (the hypothalamus and the protocerebral cells respectively), which themselves probably have a neurocrine function.

The corpus cardiacum (or paracardiacum) is made up of two sorts of cells: chromophil cells which stain deeply with hæmatoxylin after osmic acid fixation, and chromophobe cells, which are probably glial in nature. The chromophil cells are regarded by Cazal as modified neurones, which give off ramifying processes with bulbous extremities discharging their secretion into the blood. In the corpora allata, droplets of secretion with similar staining properties are formed in association with the mitochondria. Further secretory droplets are to be seen along the nerve fibres which connect the neuro-secretory cells of the protocerebrum with the corpus cardiacum.

A very clear account is given of the puzzling structures which make up Weismann's ring in the larvæ of the higher Diptera. There is general agreement that the small dorsal cells represent the corpus allatum; the ventral cells of chromophil and chromophobe types are clearly the corpus cardiacum; Cazal supports E. Thomsen and others in regarding the large lateral cells as pericardial cells which have secondarily acquired an endocrine function. But this last conclusion is based only on the general appearance of these cells. They contain droplets which stain with osmic acid and potassium iodide, a reaction that is thought to be specific for certain phenolic compounds.

V. B. WIGGLESWORTH

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN PHYSICS—The Registrar, Technical College, Sunderland (August 6).

SENIOR PROFESSIONAL OFFICER (Physiology), to take charge of the Plant Physiology Section of the Western Province Fruit Research Station, Stellenbosch—The Secretary, Union of South Africa, South Africa House, Trafalgar Square, London, W.C.2 (August 6).

ASSISTANT LECTURER IN AGRICULTURE, and an ASSISTANT LECTURER IN BIOLOGY—The Clerk to the Governors, Essex Institute of Agriculture, Writtle, Chelmsford (August 6).

SCIENTIST (Grade III) or a SCIENTIFIC TECHNOLOGIST (Grade I) in the Fife and Clackmannan Area Laboratory, Cowdenbeath—The Establishments Officer, National Coal Board, 1 Eglinton Crescent, Edinburgh (August 6).

PLANT PATHOLOGIST (Scientific Officer grade) in connexion with potato storage investigations being carried out at the University of Nottingham School of Agriculture, Sutton Bonington—The Secretary, Agricultural Research Council, 6a Dean's Yard, London, S.W.1 (August 8).

METALLURGICAL CHEMIST IN CHARGE, Dominion Laboratory—The Office of the High Commissioner for New Zealand, 415 Strand, London, W.C.2 (August 10).

LECTURER IN ENGINEERING—The Registrar, Merchant Venturers' Technical College, Bristol 1, endorsed 'L.E.' (August 13).

SENIOR LECTURER or LECTURER IN ANATOMY, DEMONSTRATORS IN ANATOMY, a LECTURER IN INDUSTRIAL HYGIENE, a LECTURER or ASSISTANT LECTURER IN THE DEPARTMENT OF BACTERIOLOGY, and a LECTURER or ASSISTANT LECTURER IN THE DEPARTMENT OF BOTANY—The Registrar, The University, Sheffield (August 13).

SENIOR ASSISTANT IN MECHANICAL ENGINEERING in the Engineering (Non-Faculty) Department—The Registrar, Merchant Venturers' Technical College, Bristol 1, endorsed 'S.A.E.' (August 13).

BRITISH COKE RESEARCH ASSOCIATION FELLOWSHIP—The Registrar, The University, Sheffield (August 15).

ASSISTANT LECTURER IN THE DEPARTMENT OF ELECTRICAL ENGINEERING—The Secretary, University College, Gower Street, London, W.C.1 (August 15).

RESEARCH OFFICER IN THE COAL RESEARCH SECTION of the Division of Fuel Research, Sydney (Ref. No. 2183), a RESEARCH OFFICER IN THE DIVISION OF ELECTROTECHNOLOGY, National Standards Laboratory, Sydney (Ref. No. 2310), and a RESEARCH OFFICER IN THE BUILDING RESEARCH SECTION, Melbourne (Ref. No. 2320)—The Chief Scientific Liaison Officer, Australian Scientific Research Liaison Office, Africa House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (August 20).

ASSISTANT IN THE BOTANY DEPARTMENT—The Secretary, The University, Aberdeen (August 20).

SENIOR LECTURER or LECTURER IN PHYSIOLOGY, and an ASSISTANT LECTURER IN PHYSIOLOGY—The Registrar, The University, Sheffield (August 27).

ASSISTANT LECTURER or LECTURER IN STATISTICS—The Registrar, The University, Leeds 2 (August 27).

PROFESSOR OF GENETICS, a PROFESSOR OF ENTOMOLOGY, a PROFESSOR OF AGRICULTURAL CHEMISTRY (Chemistry of Insecticides and Fungicides), a PROFESSOR OF ANIMAL PRODUCTION, a PROFESSOR OF SOIL SCIENCE, a PROFESSOR OF DAIRY, a PROFESSOR OF PLANT BREEDING, and a PROFESSOR OF AGRICULTURAL ECONOMY, at Farouk I University, Alexandria—The Director, Egyptian Education Bureau, 4 Chesterfield Gardens, London, W.1 (August 31).

ASSISTANT CURATOR (male) in the Botany Department of the Natural History Museum—The Town Clerk, The Guildhall, Nottingham (August 31).

PROFESSOR OF PHARMACEUTICAL CHEMISTRY, a PROFESSOR OF PHARMACOGNOSY, a PROFESSOR OF PHARMACOLOGY, and a PROFESSOR OF PHARMACEUTICS, in the Faculty of Medicine Pharmacy School of Farouk I University, Alexandria—The Director, Egyptian Education Bureau, 4 Chesterfield Gardens, London, W.1 (August 31).

TECHNICAL ASSISTANT (Grade II) IN THE DEPARTMENT OF PHYSICS—The Registrar, The University, Nottingham.

SENIOR MEDICAL LABORATORY TECHNICIAN IN THE PATHOLOGICAL LABORATORY—The Secretary, Rochdale and District Hospital Management Committee, 132 Drake Street, Rochdale.

ASSISTANT PHYSICIST—The Secretary, Lambeth Group Hospital Management Committee, Renfrew Road, London, S.E.11.

LECTURER IN CHEMISTRY, to teach to Intermediate and Final B.Sc. standard—The Clerk, Northern Polytechnic, Holloway, London, N.7.

LECTURERS (part-time) ON MECHANICAL OR CIVIL ENGINEERING subjects to University Degree standard, and DEMONSTRATORS (University Graduates in Engineering) as Demonstrators in the Mechanical and Civil Engineering Department—The Principal, Battersea Polytechnic, Battersea, London, S.W.11.

LECTURER IN METALLURGY—The Principal, Central Technical College, Suffolk Street, Birmingham 1.

LECTURER IN MICROBIOLOGY at the Massey Agricultural College, Palmerston North—The High Commissioner for New Zealand, 415 Strand, London, W.C.2.

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